Syllabus
Course Program

Eco-innovations in the Development of New Technologies

Specialty
101 – Ecology

Educational program
Engineering Ecology

Level of education
Master's level

Semester
1

Institute
Institute of Education and Science in Mechanical Engineering and Transport

Department
Department of Chemical Engineering and Environment Protection (154)

Course type
Special (professional), Mandatory

Language of instruction
English, Ukrainian

Lecturers and course developers

Olesia Filenko

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Candidate of Technical Sciences, Associated Professor

He has 20 years of experience. Author and co-author of more than 50 scientific and educational works.
Leading lecturer in the following disciplines: "Introduction to the specialty", "Environmental Impact Assessment and Strategic Environmental Assessment", "Environmental Control and Audit, Environmental Risk Management", "Environmental Management", "Eco-innovations in the Development of New Technologies".
More about the lecturer on the department's website

General information

Summary

The discipline is aimed at forming a holistic system of knowledge about environmental innovations as a factor in the balanced development of industrial enterprises and society as a whole.

Course objectives and goals

To know the essence and content of environmental innovations and innovation activities, to understand the place of environmental innovation management in the system of balanced development of enterprises; to know the mechanism of state regulation of innovation; to know the principles of the mechanism of implementation of environmental innovations; to master the principles of development of low-waste and zero-waste production; to understand the principles of cyclicality of material flows; to be able to apply the principle of integrated use of raw materials and secondary material resources when drawing up schemes.

Format of classes

Lectures, practical work, consultations. Calculated task. Final control in the form of an exam.

Competencies

GC-1. The ability to learn and master modern knowledge.
GC-2. The ability to make informed decisions.
GC-4. Competence to develop and manage projects.
GC-6. Competence to search, process, and analyze information from various sources.
SC-1. Awareness of the latest achievements necessary for research and/or innovation in the field of ecology, environmental protection, and sustainable use of natural resources.
SC-2. Ability to apply interdisciplinary approaches in critically analyzing ecological problems.
SC-3. Ability to use principles, methods, and organizational procedures of research and/or innovation activities.
SC-7. Ability to organize work related to the assessment of the environmental status, environmental protection and nature management optimization, in conditions of incomplete information and conflicting requirements.
SC-8. Ability for self-education and professional development based on innovative approaches in the field of ecology, environmental protection, and balanced nature management.
SC-9. Ability to independently develop ecological projects through the creative application of existing and generating new ideas.
SC-10. Ability to assess the level of negative impact of natural and anthropogenic factors of ecological danger on the environment and human.

Learning outcomes

RE-1. Know and understand the fundamental and applied aspects of environmental sciences.
RE-2. Be able to use conceptual ecological patterns in professional activities.
RE-10. Demonstrate awareness of the latest principles and methods of environmental protection.
RE-11. Be able to use modern information resources on ecology, nature use, and environmental protection.
RE-13. Be able to evaluate the potential impact of technological objects and economic activities on the environment.
RE-16. Choose the optimal management and/or nature use strategy depending on environmental conditions.
RE-18. Be able to use modern methods of information processing and interpretation in innovative activities.
RE-19. Be able to independently plan the implementation of innovative tasks and formulate conclusions based on their results.
RE-20. Have knowledge of the basics of ecological engineering design and environmental impact assessment.

Student workload

The total volume of the course is 120 hours (4ECTS credits): lectures - 32 hours, practical studies - 16 hours, self-study - 72 hours.

Course prerequisites

TPossession of competencies and learning outcomes provided for by the standard of higher education in the specialty 101 "Ecology" of the first bachelor's level, as well as general knowledge of natural sciences

Features of the course, teaching and learning methods, and technologies

Lectures are conducted interactively with the use of multimedia technologies.
Practical classes use reproductive and problem-solving teaching methods and focus on solving real environmental problems related to the creation of green technologies and sustainable production.

Program of the course

Topics of the lectures

Topic 1: The concept of environmental innovations and their role in the modern economy.
The essence and content of environmental innovations and innovation activities. The place of environmental innovation management in the system of balanced development of enterprises. State regulation of innovation activity. Types of environmental innovations. The main factors of influence on the eco-innovation activities of enterprises, experience in implementing environmental innovations in Ukraine and abroad.
Topic 2. Principles of the mechanism of implementation of environmental innovations.
The concept of "best available technology" (BAT) and "cleaner production" (CP). Stages of implementation of the BCA strategy. Use of the BCA strategy in various sectors of the economy.
Topic 3: Introduction to technology and its role in eco-innovation
Implementation of eco-innovations. The role of technology in eco-innovation. Adopting the life cycle of thinking and implementing the value chain.
Topic 4. Technology development and transfer methods
Assessment of the appropriate method. Assessment of the company's ability to develop or implement technologies. Technology development. Technology transfer. The process of protecting intellectual property rights (IPR). Financing of technologies for environmental innovation.
Topic 5. Challenges and policy responses to technologies for environmental innovation
Strengthening institutional capacity. Creating market demand. Increasing absorptive capacity. Enforcement of intellectual property rights. Facilitating access to finance.
Topic 6. Principles of low-waste and zero-waste production development.
Problems of creating low-waste and zero-waste production. Definition of waste-free and low-waste technology. Aspects of the problem of creating waste-free technologies.
Topic 7. The principle of cyclical material flows
The principle of recycling. Problems that are solved with the introduction of recycling in the chemical and technological system. Examples of some chemical reactions with recycling.
Topic 8. The principle of integrated use of raw materials. Secondary material resources.
The use of secondary material resources. Use of secondary energy resources.
Topic 9. The principle of rational organization of waste-free production.
General provisions. Efficiency of the organization of chemical and technological process. Factors that determine the organization of batch or continuous processes.
Topic 10. Development of a technological scheme of waste-free production.
General provisions. Choosing a place of production. Drawing up a basic technological scheme of waste-free production. General methods of developing waste-free production.
Topic 11. Environmental innovations in the energy sector.
Alternative fuels as substitutes for petroleum fuels for internal combustion engines. Biodiesel production and prospects for its use in Ukraine.
Topic 12: Environmental sustainable process for chemical and environmental engineering and science: carbon dioxide capture and utilization.
Carbon dioxide capture and utilization for efficient biofuel production.
Using carbon dioxide as a building block in the synthesis of active pharmaceutical ingredients. Carbon dioxide injection to improve oil recovery and underground storage to reduce greenhouse gases. Recent advances in the use of carbon dioxide as renewable energy. Metal-organic frameworks as an effective method of carbon dioxide capture. Industrial carbon dioxide capture and utilization. Ionic liquids for carbon capture and storage. Advances in the use of carbon dioxide for food preservation and storage. A look at the latest developments in membrane-based carbon dioxide capture and utilization. Carbon dioxide for fuel using solar energy. Adsorbents for carbon capture. Use of supercritical CO2 for drying and production of starch and cellulose aerogels. Photosynthetic cell factories, a new paradigm of carbon dioxide (CO2) valorization. Technologies for carbon dioxide capture and sequestration - current prospects, problems and prospects. Microbial fixation of carbon dioxide for the production of biopolymers. Capture of carbon dioxide and its improved utilization by microalgae.
Topic 13. Environmental innovations in the metallurgical industry.

Carbon-free production technologies. Replacement of coke. Hydrogen production. Synthesis gas. Steelmaking in electric arc furnaces using methol (recycling) and the reduction of methol use in oxygen-converter production. Capture and disposal of CO2. Green technologies that are already working.

Topic 14. Eco-innovations in the textile industry.

Materials and methods. Ecodesign. Eco-labeling. Packaging. Clean products. Eco-efficiency. Collaborations. Examples of eco-innovations in the textile industry.

Topic 15: Eco-innovations in the construction industry.

Creation of new eco-friendly materials. Decomposable materials. Renewable materials. Reuse materials. ZD printing. Cool roofs. Green insulation. Recycled concrete.

Topic 16. Eco-innovations in the food industry.

Technologies in the food industry that reduce the carbon footprint. Technologies for the production of vegetable protein. 3D printing of meat. Latest practices of green technologies in food production and processing.

Topic 17. Plant waste from agriculture and food industry as potential sorbents of organic and inorganic toxicants.

Characterization of plant waste from the agro-industrial complex and ways of its utilization. Structural and sorption properties of biosorbents. Ways to increase the absorption capacity of plant materials (walnut shells) for organic and inorganic toxicants.

Topic 18: Modern "green" technologies for the synthesis of nanomaterials.

World production and application of silver nanoparticles. The latest technologies for the production of nanomaterials of various compositions using energy-saving plasma technologies. Production of silver nanodispersions in a "green" way using extracts of agricultural waste.

Topic 19: Production of biomineral fertilizers, biogas and soda ash from secondary raw materials.

Features of the process of obtaining biomineral fertilizers and biogas from secondary raw materials. Modern methods of soda ash production. Production of biomineral fertilizers and biogas from plant material. Study of the process of obtaining a modified fertilizer from sunflower husk ash and ammonium sulfate. Production of soda ash from waste.

Topic 20: Eco-innovations in the processing of household waste.

Household waste as a secondary raw material. Examples of sustainable waste recycling.

Topics of the workshops

Topic 1: Drawing up a basic technological scheme of environmentally friendly production.
Topic 2. Stages of environmental assessment of chemical production.
Topic 3. Quantitative assessment of waste-free production.
Topic 4. Tasks to be solved with the introduction of recycles in the chemical process flow chart.
Topic 5. Determination of the coefficient of complexity of raw material use.
Topic 6. General scheme of the process of environmental assessment of projects.
Topic 7. Cases of green technologies implementation.
Topic 8: Cases of developments that are only planned to be implemented.

Topics of the laboratory classes

Laboratory classes is not included in the course.

Self-study

The course involves independent study of certain topics, for which students are provided with additional materials in the form of video presentations, articles, and links to websites to familiarize themselves with their work.

Course materials and recommended reading

1.Eco-innovation index (8th EAP). https://www.eea.europa.eu/ims/eco-innovation-index-8th-eap#:~:text=https%3A//green%2Dbusiness.ec.europa.eu/eco%2Dinnovation_en

2. Climate Change and Land: an IPCC special report on climate change, desertification. Land degradation. Sustainable land management, food security, and greenhouse gas fluxes in terretrial ecosystems [P.R. Shukla, J.Skea, E. Calvo Buendia, V. Masson-Delmotte, H. -O. Portner, D.C. Roberts, P. Zhai, R. Slade, S.

Connors, R.van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E.Huntley, K. Kissick, M. Belkacemi, J. Malley]. IPCC, 2019. 896 pages. https://www.ipcc.ch/srccl/
3. SUSTAINABLE DEVELOPMENT REPORT 2022. From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond. Jeffrey Sachs, Guillaume Lafortune, Christian Kroll, Grayson Fuller and Finn Woelm 2022. Cambridg. 494 pages. https://www.sustainabledevelopment.report/reports/sustainable-development-report-2022/
4. Noora A. Janahi, Christopher M. Durugbo, Odeh R. Al-Jayyousi, Eco-innovation strategy in manufacturing: A systematic review, Cleaner Engineering and Technology, Volume 5, 2021, 100343, ISSN 2666-7908, https://doi.org/10.1016/j.clet.2021.100343
5. Harsanto, B.; Primiana, I., Sarasi, V.; Satyakti, Y. Sustainability Innovation in the Textile Industry: A Systematic Review. Sustainability 2023, 15, 1549. https://doi.org/10.3390/su15021549
6. Iyyanki V. Muralikrishna, Valli Manickam. EScience and Engineering for Industry. Book. 2017. 669 p. https://www.sciencedirect.com/book/9780128119891/environmental-management
7. Sevil Acar, Erinç Yeldan. Handbook of Green Economics. Book, 2020, Copyright © 2019 Elsevier Inc. All rights reserved. 189. p. https://doi.org/10.1016/C2018-0-00479-X
8. John Hill, Environmental, Social, and Governance (ESG) Investing A Balanced Analysis of the Theory and Practice of a Sustainable Portfolio/ Book, 2020. 357 p. https://doi.org/10.1016/C2018-0-03866-9

Assessment and grading

Criteria for assessment of student performance, and the final score structure

100% of the final grade consists of the results of the examination (40%) and the current assessment (60%).
Examination: written assignment and oral response
Current assessment: practical work - 10%, calculation task - 10% and two current tests - 20% each.

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by

2023/08/31 

Head of the department
Oleksii SHESTOPALOV

2023/08/31 

Guarantor of the educational program
Musii TSEITLIN