MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL UNIVERSITY OF LIFE AND ECOLOGICAL SCIENCES OF UKRAINE

Department of Technical Service and Engineering Management named after M.P. Momotenko

"APPROVED"
Dean of the Engineering and Design Faculty

_____ Zinoviy RUZYLO

"____" June 2025

"APPROVED"
at the Technical Service and Engineering Management Department named after M.P. Momotenko
Protocol № ___ dated "___" June 2025 p.
Head of Department
_____ Ivan ROGOVSKII

"REVIEWED"
Guarantor of the Programme "Technical Service of Agricultural Machinery and Equipment"

Andrii NOVYTSKYI

**COURCE HANDBOOK
OF THE ACADEMIC DISCIPLINE**

ENERGY AND ECOLOGICAL ASSESSMENT OF MACHINE DESIGNS

Field of knowledge: G – Engineering, Manufacturing, and Construction
Specialty: G11 – Mechanical Engineering (by specialisations)
Educational and professional programme: Technical Service of Agricultural Machinery and Equipment
Engineering and Design Faculty
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Kyiv – 2025 p.

Course Description
Energy and Ecological Assessment of Machine Designs

The discipline "Energy and Ecological Assessment of Machine Designs" is one of the mandatory components of the educational curriculum. It defines the uniqueness of the educational and professional program and ensures the development of a comprehensive set of essential knowledge and skills in the training of master's degree students under the program "Technical Service of Agricultural Machinery and Equipment".

The objective of the discipline is to develop students' ability to research, model, design, and conduct energy and Ecological assessments of machine designs. It also aims to form professional knowledge of the theoretical, practical, and methodological foundations, as well as the tools used in energy and Ecological assessment. Additionally, the course fosters the ability to apply acquired knowledge and skills to address challenges in the context of agricultural production systems.

Field of Knowledge, Area of Training, Specialization, Educational Level		
Educational Degree	*Master's Degree*	
Specialization	*G11* – Mechanical Engineering *(by specialization)*	
Educational Program	*Technical Service of Agricultural Machinery and Equipment*	
Characteristics of the Academic Discipline		
Type	*Core*	
Hours	*180*	
ECTS Credits	*6*	
Content Modules	*2*	
Course Project (if applicable)	*–*	
Form of Final Assessment	*Test, Exam*	
Indicators of the Academic Discipline by Form of Study		
	Full-Time	Part-Time
Year of Study (Course)	*1*	–
Semester	*1, 2*	–
Lectures	*45 hours*	–
Practical Classes / Seminars	-	–
Laboratory Classes	*45 hours*	–
Personal Activities	*90 hours*	–
Weekly Classroom Hours for full-time study	*6 hours*	–

1. Aim, Competencies, and Learning Outcomes of the Academic Discipline

The aim of the discipline is to create the conditions for the development of students' program-specific competencies that enable them to acquire essential knowledge, skills, and abilities necessary for further professional and research-oriented activities in the field.

Acquired Competencies:

Integral Competence (IC): the ability to solve complex problems and tasks in mechanical engineering (by specialization), which involve research and/or innovation and are characterized by uncertain conditions and requirements.

General Competencies (GC):

GC01. Ability to use information and communication technologies.

GC03. Ability to search, process, and analyse information from various sources.

GC07. Ability to identify, formulate, and solve problems.

GC08. Ability to make reasoned decisions.

Special (Professional) Competencies (SC):

SC02. Critical understanding of advanced scientific facts, concepts, theories, and principles in the field of sectoral mechanical engineering and the ability to apply them to solve complex tasks and ensure sustainable development.

SC04. Awareness of the future challenges of modern production aimed at meeting consumer demands; proficiency in trends of innovative development in the field.

SC06. Ability to select and apply modern technologies, equipment, and tools for the design, reconstruction, or technical modernization of service enterprises.

Program Learning Outcomes (PLO):

PLO04. Perform engineering calculations to solve complex tasks and practical problems in sectoral mechanical engineering.

PLO05. Analyse engineering objects, processes, and methods.

PLO06. Search for relevant scientific and technical information from available sources, including in foreign languages; analyse and evaluate it.

PLO07. Prepare production processes and operate sector-specific mechanical engineering products throughout their life cycle.

2. Course Program and Structure

Module / Topic Title	Total Hours												
	Full-Time							Part-Time					
	Weeks	Total Hours	including										
			Lectures	Practical	Labs	Individual	Personal Activities						
1	2	3	4	5	6	7	8						
1st semester													
Content Module 1: **Life cycle of machines and equipment. A systematic approach to evaluating, modelling and improving the design of machines and equipment**													
Topic 1. Energy and ecological assessment of agricultural machines designs. Key concepts and terminology.	1-2	8	3	–	–	–	5	–	–	–	–	–	–
Topic 2. Concept of sustainable development and ecologically clean production.	3-4	6	2	–	–	–	4	–	–	–	–	–	–
Topic 3. Life cycle of machines and equipment.	5-6	9	2	–	3	–	4	–	–	–	–	–	–
Topic 4. Ecological management tools.	6-7	8	2	–	2	–	4	–	–	–	–	–	–
Topic 5. Energy management tools.	7-8	8	2	–	2	–	4	–	–	–	–	–	–
Topic 6. Life Cycle Assessment (LCA) of machines and equipment.	8-9	10	2	–	4	–	4	–	–	–	–	–	–
Topic 7. Use of models in system analysis of machine and equipment designs.	9-10	6	2	–	–	–	4	–	–	–	–	–	–
Topic 8. Energy passport of machines and equipment.	10-11	8	2	–	2	–	4	–	–	–	–	–	–
Topic 9. Ecological passport of machines and equipment.	11-12	8	2	–	2	–	4	–	–	–	–	–	–
Topic 10. Ergonomic requirements for modern machines and equipment design.	13-14	10	2	–	4	–	4	–	–	–	–	–	–
Topic 11. Ergonomic and technological design as a method to reduce ecological impact.	14-15	10	2	–	4	–	4	–	–	–	–	–	–
Total for Module 1:	**91**		**23**	–	**23**	–	**45**	–	–	–	–	–	–
2nd semester													
Content Module 2: **Waste management - energy and ecological assessment of machines operating on biofuels and energy from alternative sources.**													
Topic 12. Key definitions in waste management. Waste classifications.	1-2	6	2	–	–	–	4	–	–	–	–	–	–

Topic	Week	Total										
Topic 13. Waste management mechanisms. EU waste management systems.	3-4	6	2	–	–	–	4	–	–	–	–	–	–
Topic 14. General characteristics of solid industrial waste. Operations related to the management of solid industrial waste.	5-6	8	2	–	2	–	4	–	–	–	–	–	–
Topic 15: Scenarios for the development of the ecological situation. Mechanisms for improving the state of the environment.	6-7	6	2	–	–	–	4	–	–	–	–	–	–
Topic 16. Energy and ecological assessment of machines operating on liquid biofuels.	7-8	10	2	–	4	–	4	–	–	–	–	–	–
Topic 17. Assessment of machines using solid biofuels.	8-9	10	2	–	4	–	4	–	–	–	–	–	–
Topic 18. Assessment of machines using gaseous biofuels.	9-10	10	2	–	4	–	4	–	–	–	–	–	–
Topic 19. Assessment of machines operating on solar energy.	10-11	10	2	–	4	–	4	–	–	–	–	–	–
Topic 20. Assessment of heat pump systems.	11-12	8	2	–	2	–	4	–	–	–	–	–	–
Topic 21. Assessment of machines utilizing low-temperature heat sources.	13-14	6	2	–	–	–	4	–	–	–	–	–	–
Topic 22. Application of AI in energy and ecological assessment of machinery and equipment.	14-15	9	2	–	2	–	5	–	–	–	–	–	–
Total for Module 2:		**89**	**22**		**22**	–	**45**	–	–	–	–	–	–
Total Course Hours:		**180**	**45**		**45**	–	**90**	–	–	–	–	–	–

Module 1. Life cycle of machines and equipment. A systematic approach to evaluating, modelling and improving the design of machines and equipment.

Topic 1. Energy and ecological assessment of agricultural machines designs. Key concepts and terminology. Key concepts and terminology. Energy and ecological assessment and its role in the systems analysis of agricultural machines and equipment. Core energy and ecological performance indicators for evaluating agricultural machinery designs. Fundamental terminology of energy and ecological analysis in agricultural engineering. Influence of design features on energy consumption and ecological load in agro-industrial systems. Modern approaches and methods for energy and ecological assessment of agricultural machines and equipment.

Topic 2. Concept of sustainable development and ecologically clean production. Essence of the sustainable development concept and its core principles. The role of ecologically friendly production in achieving sustainable development goals.

Ecological, economic, and social factors in implementing sustainable production principles. Examples and strategies for clean production in modern agriculture. International and national initiatives supporting sustainable and ecologically safe production.

Topic 3. Life cycle of machines and equipment. Definition and stages of a machine's life cycle: design, manufacturing, operation, maintenance, disposal. Ecological impact assessment at each life cycle stage (energy use, emissions, waste, resource consumption). Life cycle analysis methods (tools, standards, evaluation approaches). Design optimization considering the full life cycle (improved energy efficiency, reduced operational costs, ease of recycling). Role of life cycle thinking in engineering and management decisions.

Topic 4. Ecological management tools. Ecological management systems (EMS) and international standards. Ecological auditing and monitoring. Eco-labelling and ecological certification. Ecological reporting.

Topic 5. Energy management tools. Energy management systems (EnMS) and ISO 50001 standard. Energy auditing. Monitoring and accounting of energy consumption. Energy efficiency indicators and KPIs. Software and digital tools for energy management.

Topic 6. Life Cycle Assessment (LCA) of machines and equipment. The role of LCA in sustainable design of machinery and equipment. Comparative evaluation of alternative designs using LCA. Identification of ecological impact hotspots within the life cycle. Integration of LCA results into production and operational decision-making. Limitations and challenges of LCA application in agroengineering and machinery design (lack of precise data, complexity of modelling, time and resource constraints).

Topic 7. Use of models in system analysis of machine and equipment designs. Concepts of modelling in the system analysis of technical objects. Formalization of machine designs as system analysis objects. Mathematical modelling of relationships among design components. Simulation modelling for predicting machine and equipment behaviour. Decision-making models for selecting optimal design solutions.

Topic 8. Energy passport of machines and equipment. Purpose and structure of the energy passport. Energy efficiency indicators documented in the passport. Methods for calculating and measuring energy characteristics. Significance of energy passports for technical accounting and energy planning. Use of energy passports in machinery energy management systems.

Topic 9. Ecological passport of machines and equipment. Purpose of the ecological passport and its role in controlling ecological impacts. Key sections and their content. Regulatory framework and documentation requirements. Methods for collecting, analysing, and verifying ecological data. Use of ecological passports in manufacturing, operation, and certification practices.

Topic 10. Ergonomic requirements for modern machines and equipment design. Adapting machine design to human physical and psychophysiological characteristics. Optimization of the operator's workstation. Safety and reduction of physical strain. Information ergonomics. Consideration of different working conditions and user categories.

Topic 11. Ergonomic and technological design as a method to reduce ecological impact. Impact of ergonomic design on reduced energy consumption and

increased machine performance. Technological design as a factor in minimizing production waste and pollution. Reduced ecological impact through enhanced reliability and durability. Integration of ergonomic and technological solutions to create ecologically safe products. Promoting ecological awareness by improving working conditions and processes.

Module 2. Waste management – energy and ecological assessment of machines operating on biofuels and energy from alternative sources.

Topic 12. Key definitions in waste management. Waste classifications. Definition of "waste". Classification of waste by source and hazard level. Key terminology in waste management.

Topic 13. Waste management mechanisms. EU waste management systems. Main mechanisms of waste management. Principles of the EU Waste Hierarchy. EU regulatory framework (Waste Framework Directive, Packaging and Packaging Waste Directive, REACH Regulation). Integrated waste collection and separation systems in the EU. Innovative technologies and circular economy approaches in EU waste management.

Topic 14. General characteristics of solid industrial waste. Operations related to the management of solid industrial waste. Classification and sources of solid industrial waste. Impact of solid industrial waste on the environment and human health. Assessment of the volume, morphology and composition of solid industrial waste. Basic operations for handling solid industrial waste. Modern technologies and approaches to reducing waste generation and reuse.

Topic 15. Scenarios for the development of the ecological situation. Mechanisms for improving the state of the environment. The current state of the environment: global and regional challenges. Forecasting the ecological situation: scenarios for sustainable and critical development. Legal, economic and institutional mechanisms for ecological protection. Technical and technological measures to improve the state of the environment. The role of education, science and the public in ensuring ecological safety.

Topic 16. Energy and ecological assessment of machines operating on liquid biofuels. Characteristics of liquid biofuels (biodiesel, bioethanol) and their impact on engine and fuel system design. Energy efficiency analysis of machines using liquid biofuels. Ecological performance: GHG emissions, toxic substances, combustion by-products. Influence of fuel quality and operating conditions on durability and reliability. Prospects for machine design improvements to meet energy and ecological safety requirements.

Topic 17. Assessment of machines using solid biofuels. Design specifics of machines adapted for solid biofuels. Energy efficiency and ecological indicators. Influence of biofuel quality on machine durability and technical condition. Potential design improvements for energy and ecological performance.

Topic 18. Assessment of machines using gaseous biofuels. Design features of machines producing and operating on gaseous biofuels. Energy efficiency: engine efficiency comparison, fuel optimization, gas composition impact. Ecological assessment of operating characteristics. Influence of gas quality on design reliability. Development prospects for machines aligned with energy and ecological standards.

Topic 19. Assessment of machines operating on solar energy. Design features incorporating solar elements (photovoltaic panels, battery systems, control electronics). Energy efficiency and performance of solar-powered machines. Ecological life cycle impact assessment. Advantages of solar energy in reducing GHG emissions. Prospects for integrating solar technology in agricultural machine design.

Topic 20. Assessment of heat pump systems. Principle of operation and design features of heat pumps. Energy efficiency and ecological impact over the system's life cycle. Role of design in minimizing GHG emissions. Opportunities for innovation and modernization in heat pump designs.

Topic 21. Assessment of machines utilizing low-temperature heat sources. Design features of machines utilizing low-temperature thermal energy. Efficiency of low-temperature energy use. Ecological impacts during operation. Influence of design on system reliability and longevity. Prospects for adopting technologies for efficient use of low-temperature heat.

Topic 22. Application of AI in energy and ecological assessment of machinery and equipment. Application of machine learning algorithms for analysing energy use and ecological indicators. Intelligent data collection and processing from sensors and monitoring systems. Optimization of design decisions based on AI-driven simulations and models. Integration of AI into energy and ecological management systems for automated decision-making. Use of neural networks and expert systems for risk assessment and impact mitigation strategies.

3. Lectures

№	Topic	Hours
1	Energy and ecological assessment of agricultural machines designs. Key concepts and terminology.	3
2	Concept of sustainable development and ecologically clean production.	2
3	Life cycle of machines and equipment.	2
4	Ecological management tools.	2
5	Energy management tools.	2
6	Life Cycle Assessment (LCA) of machines and equipment.	2
7	Use of models in system analysis of machine and equipment designs.	2
8	Energy passport of machines and equipment.	2
9	Ecological passport of machines and equipment.	2
10	Ergonomic requirements for modern machines and equipment design.	2
11	Ergonomic and technological design as a method to reduce ecological impact.	2
12	Key definitions in waste management. Waste classifications.	2
13	Waste management mechanisms. EU waste management systems.	2
14	General characteristics of solid industrial waste. Operations related to the management of solid industrial waste.	2
15	Scenarios for the development of the ecological situation. Mechanisms for improving the state of the environment.	2
16	Energy and ecological assessment of machines operating on liquid biofuels.	2
17	Assessment of machines using solid biofuels.	2
18	Assessment of machines using gaseous biofuels.	2
19	Assessment of machines operating on solar energy.	2
20	Assessment of heat pump systems.	2
21	Assessment of machines utilizing low-temperature heat sources.	2

22	Application of AI in energy and ecological assessment of machinery and equipment.	2
	Total	45

4. Laboratory and practical works

№	Topic	Hours
1.	Analyse the life cycle stages of an agricultural machine considering technical and ecological performance indicators.	3
2.	Assess the compliance of a machine's (or equipment's) design with ISO 14001 standards and ecological audit requirements.	2
3.	Determine the energy consumption of the machine (equipment) using the energy balance method and develop recommendations for its reduction.	2
4.	Develop an LCA model to assess the ecological impact throughout the machine's life cycle using software such as SimaPro, SolidWorks, or equivalents.	4
5.	Examine the machine's (equipment's) energy characteristics and develop an energy passport.	2
6.	Examine the machine's (equipment's) ecological characteristics and develop an ecological passport.	2
7.	Develop recommendations for achieving an energy-efficient and CO_2-neutral machine (equipment) design considering technological and ergonomic requirements.	4
8.	Apply tools of energy and ecological management to develop a maintenance schedule (calendar plan) for the machine (equipment).	4
9.	Develop methods for waste disposal generated during the manufacturing, maintenance, repair, and decommissioning of machinery and equipment.	2
10.	Study the energy efficiency and emission levels of an internal combustion engine operating on biodiesel compared to conventional diesel fuel.	4
11.	Investigate the energy and ecological performance indicators of machines operating on solid biofuels and fossil-based fuels.	4
12.	Investigate the energy and ecological performance indicators of machines operating on producer gas and fossil-based fuels.	4
13.	Analyse the design and technological parameters of battery systems for application in electric vehicles.	4
14.	Study the CO_2 emission levels associated with agricultural crop cultivation.	2
15.	Apply artificial intelligence algorithms to identify and justify the energy and ecological performance indicators of the machine (equipment).	2
	Total	45

5. Personal Activities

№	Topic	Hours
1	Conduct a review and classification of key energy and ecological performance indicators used in the assessment of agricultural machinery. Provide examples from technical documentation.	5
2	Analyse and compare at least three methods for assessing the energy efficiency of agricultural machinery.	4
3	Examine two agricultural machines with different design solutions. Evaluate how these design features influence the level of ecological impact.	4
4	Complete a comparative table for two machinery models (traditional vs. modern) with an analysis of their energy and ecological characteristics.	4
5	Calculate the conditional energy load of a unit of agricultural equipment during a specific agrotechnical operation.	4
6	Conduct a life cycle assessment (LCA) for a seed drill (or other agricultural machine).	4

7	Analyse a case study involving the use of a mathematical or computer model for optimizing agricultural machine design. Describe the system analysis elements used.	4
8	Make the structure and content of an energy passport for a grain harvester. Identify key energy characteristics and methods for their determination.	4
9	Prepare an example of an ecological passport for agricultural machinery, specifying key parameters: emission types, noise level, material recyclability, etc.	4
10	Analyse ergonomic design solutions in a modern tractor or combine. Determine their influence on operator workload reduction and productivity improvement.	4
11	Justify how ergonomic and technological design solutions can contribute to minimizing ecological impact. Provide specific examples from agricultural machinery.	4
12	Make a table of core terms and definitions in the field of waste management based on Ukrainian and EU legislation. Classify agricultural waste types.	4
13	Analyse the waste management system in an EU country (of your choice) and identify elements that can be adapted for Ukraine's agricultural sector.	4
14	Design a basic industrial waste management plan for a hypothetical enterprise. Include an overview of the waste management stages and a brief description of each one.	4
15	Analyse one of the international initiatives or agreements, such as the Paris Climate Agreement or the UN Sustainable Development Goals, and write a short report on its key features, goals, and importance for Ukraine.	4
16	Perform an energy and ecological assessment of an assigned agricultural machine operating on biodiesel or ethanol. Compare its advantages and disadvantages with a diesel counterpart.	4
17	Prepare an analytical brief on the efficiency and ecological impact of a boiler or installation using wood pellets or agro-pellets. Assess emissions and thermal efficiency.	4
18	Develop a comparative analysis of an engine running on biogas and a gasoline engine, using criteria such as energy consumption and ecological performance.	4
19	Create an energy and ecological profile for a specified machine (e.g., solar-powered drying complex or photovoltaic unit). Analyze the ecological advantages of solar energy use.	4
20	Calculate the energy efficiency of an air-to-water heat pump system for an agricultural enterprise. Assess its ecological advantages compared to gas or solid-fuel heating.	4
21	Prepare a review of machine designs utilizing geothermal or waste low-grade heat (e.g., soil heat, wastewater heat). Evaluate the potential for CO_2 emissions reduction.	4
22	Provide an overview of artificial intelligence applications for forecasting and optimizing energy use and ecological impact in agricultural machinery. Include examples of AI-based tools or models.	5
Total		90

6. Methods and Tools for Learning Outcome Assessment:
- Oral or written questioning;
- Testing (thematic, modular, final);
- Interviews;
- Laboratory, practical, and personal activities evaluation;
- Final examination.

7. Teaching Methods:
- Problem-based learning methods (lectures, discussions, interviews);
- Practice-oriented learning methods (practical classes);
- Visual methods (illustrations, demonstrations);

- Academic discussion methods;
- Work with educational and methodological literature (note-taking, abstracting, reviewing);
- Video methods (distance learning, multimedia, web-based formats);
- Personal activities (completion of assignments);
- Personal scientific and research work of higher education students.

8. Learning Outcome Evaluation:
- Final examination;
- Oral or written questioning;
- Modular testing;
- Thematic testing;
- Practical works presentation;
- Presentation of report of personal activities;
- Presentations and participation in academic events.

Student performance is assessed on a 100-point scale and converted to the national grading system in accordance with the current "Regulations on Examinations and Credits at NUBiP of Ukraine."

9.1. Distribution of points by learning activities

Type of Learning Activity	Learning Outcomes	Points
Module 1. **Life cycle of machines and equipment. A systematic approach to evaluating, modelling and improving the design of machines and equipment.**		
Lab Work 1	Analyse the life cycle stages of an agricultural machine considering technical and ecological performance indicators.	10
Lab Work 2	Assess the compliance of a machine's (or equipment's) design with ISO 14001 standards and ecological audit requirements.	10
Lab Work 3	Determine the energy consumption of the machine (equipment) using the energy balance method and develop recommendations for its reduction.	10
Lab Work 4	Develop an LCA model to assess the ecological impact throughout the machine's life cycle using software such as SimaPro, SolidWorks, or equivalents.	10
Lab Work 5	Examine the machine's (equipment's) energy characteristics and develop an energy passport.	10
Lab Work 6	Examine the machine's (equipment's) ecological characteristics and develop an ecological passport.	10
Lab Work 7	Develop recommendations for achieving an energy-efficient and CO_2-neutral machine (equipment) design considering technological and ergonomic requirements.	10
Lab Work 8	Apply tools of energy and ecological management to develop a maintenance schedule (calendar plan) for the machine (equipment).	10
Personal activities	Completion of individual assignment using English-language sources. The topics are listed in Table 5.	5
Module control	Based on topics 1–11.	15
Total for Module 1		**100**

Course Work (M1 + M2)/2·0.7		**≤70**
Additional points (answers to control/extra questions, recognition of informal education, other coursework)		**10**
Exam		**30**
Total for the first semester (Course Work + Exam)		**≤100**
Module 2. **Waste management - energy and ecological assessment of machines operating on biofuels and energy from alternative sources.**		
Lab Work 9	Develop methods for waste disposal generated during the manufacturing, maintenance, repair, and decommissioning of machinery and equipment.	10
Lab Work 10	Study the energy efficiency and emission levels of an internal combustion engine operating on biodiesel compared to conventional diesel fuel.	10
Lab Work 11	Investigate the energy and ecological performance indicators of machines operating on solid biofuels and fossil-based fuels.	10
Lab Work 12	Investigate the energy and ecological performance indicators of machines operating on producer gas and fossil-based fuels.	10
Lab Work 13	Analyse the design and technological parameters of battery systems for application in electric vehicles.	10
Lab Work 14	Study the CO_2 emission levels associated with agricultural crop cultivation.	10
Lab Work 15	Apply artificial intelligence algorithms to identify and justify the energy and ecological performance indicators of the machine (equipment).	10
Personal activities	Completion of individual assignment using English-language sources. The topics are listed in Table 5.	15
Module control	Based on topics 12–22.	15
Total for Module 2		**100**
Course Work (M1 + M2)/2·0.7		**≤70**
Additional points (answers to control/extra questions, recognition of informal education, other coursework)		**10**
Exam		**30**
Total for the second semester (Course Work + Exam)		**≤100**

9.2. Grading Scale for Higher Education Learners

Student Rating (Points)	Grade according to the National Grading System
90-100	Excellent
74-89	Good
60-73	Satisfactory
0-59	Unsatisfactory

9.3. Assessment Policy

Deadlines and Retake Policy	Assignments submitted past the deadline without valid reasons will receive a reduced grade. Module retakes are permitted only with the lecturer's approval and based on valid documented reasons (e.g., temporary incapacity due to health issues).
Academic Integrity Policy	Cheating during tests and examinations is strictly prohibited, including the use of mobile devices. Written assignments must include proper in-text citations and references to all used sources.
Attendance Policy	Attendance is mandatory. In justified cases (e.g., temporary medical conditions, international mobility programs), students may follow an individual learning plan in an online format upon approval from the dean's office.

10. Instructional and Methodological Support:

- Electronic learning course of the academic discipline:: https://elearn.nubip.edu.ua/course/view.php?id=3785
- Textbooks:

Відновлювана енергетика в аграрному виробництві / Скидан О.В., Голуб Г.А., Кухарець С.М., Ярош Я.Д., Чуба В.В., Цивенкова Н.М., Марус О.А., Павленко М.Ю.; за ред. О.В. Скидана і Г.А. Голуба. Житомир-Київ: Поліський університет-НУБіП України, 2022. 422 с.

Renewable energy in agriculture / G.A. Golub, O.V. Skydan, S.M. Kukharets, N.M. Tsyvenkova, O.A. Marus, Y.D. Yarosh, V.V. Chuba, M.Yu. Pavlenko; edited by G.A. Golub and O.V. Skydan. Kyiv-Zhytomyr: NULES of Ukraine-Polissia University, 2023. 400 p.

Машини та обладнання для біоенергетики: навчальний посібник / Голуб Г. А., Цивенкова Н. М., Марус О. А., Павленко М. Ю., Яременко О. А.; за ред. Г. А. Голуба. К.: НУБіП України, 2022. 203 с.

Energy in Agroecosystems. A Tool for Assessing Sustainability / Edited ByCasado, Manuel Gonzalez de Molina. 1st Edition. ImprintCRC Press, 2017. 470 p.

Video materials for lecture sessions: https://www.youtube.com/channel/UC4Er35uvbhLNogXUqJAuE0Q

11. Recommended Information Sources
Basic:

1. Interaction of tractors running systems with a fertile soil layer. Mechanical and technological bases: monograph / Golub G., Chuba V., Kukharets S. [and other]; edited by G. Golub. Parnu: MSDLAB OU of Estonia, 2020. 192 с.

2. Біопалива: Технології, машини, обладнання / [В.О. Дубровін, М.О. Корчемний, І.П. Масло та ін.]. К.: ЦТІ «Енергетика і електрифікація», 2004. 256 с.

3. Голуб Г.А., Сидорчук О.В., Кухарець С.М., Гох В.В., Осауленко С.В., Завадська О.А., Рубан Б.О., Поліковська Н.Л., Швець Р.Л., Чуба В.В., Павленко М.Ю. Технологія переробки біологічних відходів у біогазових установках з обертовими реакторами / За ред. д-ра техн. наук, проф. Г. А. Голуба. К.: НУБіП України, 2014. 106 с.

4. ДСТУ 3868-99 Паливо дизельне. Технічні умови.

5. ДСТУ 6081:2009 Паливо моторне. Ефіри метилових жирних кислот олій і жирів для дизельних двигунів. Технічні вимоги.

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Information Resources:

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