Partner 6
KHARKIV NATIONAL AUTOMOBILE AND HIGHWAY UNIVERSITY (Ukraine)

Brief description of Partner University: *Kharkiv National Automobile and Highway University was established in 1930 from two faculties: automobile and road-construction.*

Now Kharkiv National Automobile and Highway University is one of the leading universities in Ukraine for the training of specialists for the transport complex: construction of highways, airfields and bridges; creation of parts and mechanisms of cars; ensuring environmental safety; traffic organization.

Modern structure of the University:

– Number of faculties – 6 (Automotive faculty, Faculty of Road Construction, Faculty of Mechanics, Faculty of Management and Business, Faculty of Transport Systems, International Students Faculty) and Graduate school.

– Number of Departments – 34.

– Number of academic staff – 248.

– Number of Students – 5400.

The Department of Ecology was founded in 1992.

Directions of scientific activity of the Department:

– environmental safety of the motor transport complex and integrated environmental management;

– methodology of environmental education and the implementation of the European experience in environmental policy.

Directions of educational activity of the Department:

– preparation of bachelors, masters and doctors of philosophy in the specialty "Ecology".

– academic staff of the department are the authors more than 20 textbooks and teaching aids on environmental management and monitoring, energy-environmental and low-carbon strategies for the development of industry and transport, etc.

GENERAL DESCRIPTION OF THE TRAINING MODULE

Level of study: *Master's*
Specialty: *101 Ecology*
Branch of knowledge: *10 Natural Sciences*
Title of Educational program: *Environmental safety*
Authors team:

1. Nataliia Vnukova, Professor, Dr. of Tech. Sc.
2. Ganna Zhelnovach, Associate Professor, PhD.
3. Maryna Barun, Associate Professor, PhD.
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6. Oleksandr Kozlovskyi, PhD Student.

DESCRIPTION OF THE COURSE № 1

Environmental innovation management

Number of ECTS credits: 4

Type of course: optionally

Summary of the course: The aim of studying the course is to form a system of knowledge for students on the management of environmental innovations, the use of economic and environmental tools for assessing the feasibility of introducing an innovative component into the production process, mastering the ability to determine the resource supply of the environmental innovation market, assess the multidirectional interests of the environmental goods on the market.

Prerequisites for this course: N/A.

Competences:

– The ability to solve complex problems and problems in the field of ecology, environmental protection and balanced natural resource management in the implementation of professional activities or in the learning process, involves research and / or innovation, and is characterized by the complexity and uncertainty of conditions and requirements.

– The ability to use modern methods of environmental protection, principles of comprehensive protection of natural ecosystems and human society from environmentally hazardous natural and man-made processes (phenomena)

– Skills in the use of devices and modern equipment for assessing environmental safety in certain areas.

– Skills in obtaining, storing, processing, distributing professional and scientific and technical information;

– Ability to substantiate one's point of view in the field of ecology, environmental protection and sustainable use of natural resources.

– Skills in the use of environmental technologies to minimize the technogenic impact on natural systems.

– The ability to control the quality of the natural environment.

– Knowledge of modern innovative principles of environmentally oriented modernization of production processes;

– The ability to independently develop environmental projects by creatively applying existing and generating new ideas.

Learning outcomes:

– Be able to plan, organize and conduct comprehensive environmental studies.

– Demonstrate awareness of the latest principles and methods of environmental protection.

– Be able to carry out a system analysis procedure based on a 6-step approach.

List of lecture topics:

1. Eco-innovative activity as a component of eco-oriented development.

2. Socio-economic prerequisites for the creation and development of the market for environmental innovations.

3. The market for environmentally friendly goods and services.

4. Marketing of environmental innovations and environmental advertising.

5. International strategy for the development of green business.

6. Environmental leasing: essence, structure, directions of development and environmental consulting.

7. Environmental labeling.

8. Environmental and economic rating of the enterprise and its image.

List of practical classes, including laboratories, studios and workshops:

1. Determination of the level of environmental friendliness of goods and services.

2. Determination of the level of motivation regarding the environmental friendliness of goods of various types.

3. Marketing tools for identifying market segments for environmental innovation.

4. Promotion of an ecological product to the market.

5. Determination of the economic efficiency of the greening of the enterprise.

6. Comparison of the effects of subsidizing the prices of environmental goods at different stages of their promotion in the market.

List of self-study topics:

1. Certification of products according to the standards ISO 9001, ISO 14001, ISO 14024, ISO 14030, EMAS.

2. The market for environmental innovations.

3. Information support of the process of greening production activities.

4. Environmental certification and standardization.

5. Management of environmental and economic innovation activities at the enterprise.

6. Environmental innovation in the context of sustainable development.

7. Management of environmental innovations.

8. Motivational mechanisms for the development of eco-oriented innovations.

DESCRIPTION OF THE COURSE № 2

Modeling and forecasting of climate change

Number of ECTS credits: 4

Type of course: optionally

Summary of the course: The course is developed to familiarize students with systemic ideas about the natural and anthropogenic causes of modern global changes in the natural environment, the main factor of which is climate warming, clarification of their dynamics, impact on the natural environment and study of ways of possible prevention of the consequences of their development in the future.

The students must have a good understanding of the causes of modern climate change, the mechanism of their impact on the components of the environment and foresee the possible consequences of such an impact. The objectives of studying the course are to form a holistic system of knowledge among students regarding the methodology and organization of research on the impact of modern climatic changes on the global ecosystem of the earth.

As a result of studying the course, future specialists have to assimilate the elements of research activities, principles of organization, methods and technologies for conducting research on the impact of climate change, learn how to conduct author's research in terms of collecting climate information, theoretical premises and working hypotheses, choosing a methodology and methods for analyzing the impact of modern climate changes. Be able to apply the knowledge of monitoring and assessing the state of pollution and industrial emissions. To implement the tasks of monitoring the state of the environment, to model and predict the processes that occur in the environment. Be able to use climate models to predict climate change, use climate maps, assess the impact of various human activities on the climate.

Prerequisites for this course: N/A.

Competences:

– The ability to solve complex problems and problems in the field of ecology, environmental protection and sustainable use of natural resources in the implementation of professional activities or in the learning process, provides for research and/or innovation, and is characterized by the complexity and uncertainty of conditions and requirements.

– Skills in the use of instruments and modern equipment for assessing environmental safety in certain areas.

– Skills in the use of environmental technologies to minimize the technogenic impact on natural systems.

– The ability to analyze and assess the state of the environment using geographic information systems and technologies.

– Skills in computer networks, use of modern information technologies and software.

– Knowledge of the manifestation of individual indicators of environmental hazard, depending on its characteristics.

– The ability to organize work related to the assessment of the ecological state, environmental protection and optimization of nature management in conditions of incomplete information and conflicting requirements.

– The ability to conduct research on technogenically altered landscapes for the scientific substantiation of management decisions in order to ensure the sustainability of these landscapes.

Learning outcomes:

– Analyze, synthesize, creatively comprehend, evaluate and systematize various information sources for research in the field of ecology and environmental protection.

– Forecast the consequences of dangerous natural and anthropogenic processes (phenomena) for making management decisions.

List of lecture topics:

1. Introduction. Climate. Types of manifestation of modern changes in the natural environment. Global climate change.

2. The modern climate of Ukraine, geological and historical changes.

3. Physical, mathematical and statistical climate models. Global models in the study of the current climate and its future changes.

4. Individual regional models and their ensembles.

5. Electronic databases for verification model results of climate change.

6. Forecast of climatic indicators: projections of surface air temperature for the territory of Ukraine in the XXI century.

7. Approaches and methods for modeling greenhouse gas emissions.

8. Geographic information technology for spatial modeling of greenhouse gas emission processes.

List of practical classes, including laboratories, studios and workshops:

1. Principles of building modern climate models.

2. Comparative analysis of global and regional climate models.

3. Application of long-term models to determine trends and assess the impacts of environmental and climate change.

4. Assessment of the city's vulnerability to climate change.

5. Adaptation of biodiversity to climate change.

6. Adapting agriculture to climate change.

7. Modeling and spatial analysis of greenhouse gas emissions from the extraction and processing of various types of fuel.

List of self-study topics:

1. Historical dynamics of climatic processes.
2. The role of geological processes in global climate change.
3. The role of evolutionary processes in local climate changes.
4. Risks of climate change in Ukraine.
5. Using satellite data to predict climate change.
6. Tools for adaptation to climate change.
7. Joint implementation projects to cope with climate change.
8. Legislation of Ukraine in the field of climate change.

DESCRIPTION OF THE COURSE № 3

Sustainable development strategy of the state climate policy

Number of ECTS credits: 4

Type of course: optionally

Summary of the course: The aim of the course is to establish the patterns of development of open stationary systems, to determine the interrelationships of the energy and information characteristics of transformation processes and to study the basic principles, methods and tools for ensuring the sustainable development of social systems, taking into account the climatic component.

Objective: getting a modern understanding of the concept of sustainable development; assimilation of the theoretical foundations of the concept of sustainable development; mastering the main methodological and methodological approaches to discussing the problems of sustainable development and climate policy in the state; getting an idea of the state of development and implementation of ideas for sustainable development and climate policy in different countries.

Prerequisites for this course: N/A.

Competences:

– The ability to solve complex problems and problems in the field of ecology, environmental protection and balanced use of natural resources in the implementation of professional activities.

– The ability to apply the principles, methods and organizational procedures of scientific activity, general scientific (traditional, modern), specific scientific (interdisciplinary, special) research methods, understanding the cause-and-effect relationships of the development of society and the ability to use them in professional and social activities.

– The ability to search, process and generalize professional, scientific and technical information, knowledge in the field of modern information technologies and resources required in professional and social activities.

– Skills in obtaining, storing, processing, distributing professional and scientific and technical information.

– The ability to use the principles of co-evolution of society and nature, sustainable development in professional and social activities.

– Skills of working in computer networks, using modern information technologies and software. Knowledge of the manifestation of individual indicators of environmental hazard, depending on its characteristics.

– The ability to carry out ecological monitoring of the state of the natural environment.

Learning outcomes:

– Be able to plan, organize and conduct comprehensive environmental studies.

– Be able to carry out a system analysis procedure based on a 6-step approach.

List of lecture topics:

1. Development and essence of the concept of sustainable development of social systems, taking into account the climatic component.

2. Preservation of the biosphere as a basis for sustainable development.

3. Global computer predictive models of changes in mean annual air temperature in the lower atmosphere.

4. Criteria and indicators of sustainable development.

5. Problems and prospects of sustainable development of climate policy.

6. Economic and legal mechanisms for the transition to sustainable development.

7. Strategy and tactics for the implementation of climate policy.

8. The role of international cooperation in the preservation of climatic conditions on the planet.

List of practical classes, including laboratories, studios and workshops:

1. Discussion of the conceptual framework of the global ecological perspective of public systems, taking into account the climate component.

2. Description of the main documents on sustainable development and state climate policy.

3. Evaluation of the policy for the formation of "healthy cities".

4. Comparison of countries according to the index of sustainable development.

5. Calculation of the human development index.

6. Analysis of the volume of solid waste generation per person in different countries.

7. Assessment of the systemic essence of man and the function of nature.

8. Review of problematic issues related to sustainable development and climate change on the planet.

List of self-study topics:

1. Mechanisms of functioning and sustainability of systems, principles of environmental sustainability.

2. Problems of globalization and sustainable development.

3. Worldview, ethics and sustainable development.

4. Features of the concept of education for sustainable development.

5. The systemic essence of man, the laws of interaction between man and nature.

6. Principles of functioning of socio-economic systems.

7. Scientific prerequisites for the formation of the principles of sustainable development.

8. Modeling and forecasting scenarios in the development of sustainable development strategies and local action plans.

9. Environmental policy and sustainable development.

10. The main principles of environmental policy at the level of the state, region, industry.

11. Methods for monitoring and evaluating the environmental policy of the region, industry.

12. Environmental, socio-economic and moral aspects of production and consumption in the context of the product life cycle.

13. Monitoring the transition of society to sustainable development (indicators and indices of sustainable development, a system of global measurements of sustainable development).

14. New technologies and the role of engineering in the transition to sustainable development.

15. Formation of strategies for local sustainable development and local action plan for environmental protection.

DESCRIPTION OF THE COURSE № 4

Climate engineering technologies

Number of ECTS credits: 6

Type of course: compulsory

Summary of the course: The purpose of the course is to form students' knowledge and practical skills for the application of climate engineering technologies as a significant tool in the context of the formation of state climate policy, familiarization with the modern world market of climate technologies and the implementation of systemic technology-oriented activities for prevention, adaptation and mitigation the consequences of climate change.

Prerequisites for this course: N/A.

Competences:

– The ability to solve complex problems and problems in the field of ecology, environmental protection and balanced use of natural resources in the implementation of professional activities or in the learning process, provides for research and / or implementation of innovations, and is characterized by the complexity and uncertainty of conditions and requirements.

– The ability to use modern methods of environmental protection, the principles of comprehensive protection of natural ecosystems and human society from environmentally hazardous natural and man-made processes (phenomena).

– Skills in the use of instruments and modern equipment for assessing environmental safety in certain areas.

– The ability to apply the principles and principles of state policy in the field of environmental protection and rational use of natural resources.

– Skills in the use of environmental technologies to minimize the technogenic impact on natural systems.

– Knowledge of the theoretical foundations of ensuring the environmental safety of natural and natural-economic systems.

– The ability to control the quality of the natural environment.

– The ability to use modern equipment and apply the latest technology for research.

– Knowledge of modern innovative principles of environmentally oriented modernization of production processes.

– The ability to independently develop environmental projects by creatively applying existing and generating new ideas.

– The ability to develop and implement a set of activities to prevent climate change, adaptation and mitigation of consequences.

Learning outcomes:

– Demonstrate awareness of the latest principles and methods of environmental protection;

– To forecast the consequences of dangerous natural and anthropogenic processes (phenomena) for making management decisions.

– Participate in the development of projects and practical recommendations for the preservation of the environment with the involvement of the public;

– Be able to use national and international legal, environmental, economic and technological aspects of the functioning of the object of scientific research.

List of lecture topics:

1. General provisions for the development of ideas for climate engineering.

2. Climatic engineering. Prospects and risks.

3. Carbon footprint. Anthropogenic and technogenic factors.

4. Technologies for capturing and storing greenhouse gases.

5. Legal framework for monitoring, reporting and verification of greenhouse gas emissions.

6. Requirements for bodies for validation and verification of greenhouse gases.

7. Procedure for monitoring and reporting greenhouse gas emissions.

8. The procedure for verifying the operator's report on greenhouse gas emissions.

List of practical classes, including laboratories, studios and workshops:

1. Assessment of climate initiatives of the subjects of the modern climate market.

2. Calculation of the radiation balance of the earth's surface.

3. Assessment of the carbon footprint of anthropogenic activities.

4. Determination of the potential for the application of technologies for capturing and storing greenhouse gases.

5. Justification of activities, greenhouse gas emissions of which are subject to the procedure for monitoring, reporting and verification of greenhouse gas emissions.

6. Development of a plan for monitoring and reporting greenhouse gas emissions.

7. Risk assessments in the system of monitoring, reporting and verification of greenhouse gas emissions.

8. Calculation of the CO_2 emission factor based on the data on the composition of natural gas.

List of self-study topics:

1. Study of the effectiveness of the application of climate initiatives by the subjects of the process to prevent changes, adaptation and mitigation of the consequences of climate change.

2. Study of the effectiveness of applying the procedure for assessing the carbon footprint of anthropogenic activities in the context of prevention, adaptation and mitigation of climate change consequences.

3. Study of the effectiveness of the application of the procedure for assessing the radiation balance of the earth's surface in the context of prevention, adaptation and mitigation of climate change consequences.

4. Study on the efficiency of application of technologies for capturing and storing greenhouse gases in the context of prevention, adaptation and mitigation of climate change consequences.

5. Study of the effectiveness of the application of the procedure for justifying activities, emissions of greenhouse gases of which are subject to the procedure for monitoring, reporting and verification of greenhouse gas emissions in the context of prevention, adaptation and mitigation of climate change consequences.

6. Study of the effectiveness of the application of the plan for monitoring and reporting on greenhouse gas emissions in the context of prevention, adaptation and mitigation of climate change consequences.

7. Study of the effectiveness of the application of the risk assessment procedure in the monitoring, reporting and verification system of greenhouse gas emissions in the context of prevention, adaptation and mitigation of climate change consequences.

8. Study of the effectiveness of applying the procedure for calculating the CO_2 emission factor based on the data on the composition of natural gas in the context of prevention, adaptation and mitigation of the consequences of climate change.

DESCRIPTION OF THE COURSE № 5

Greenhouse gas capture processes

Number of ECTS credits: 4

Type of course: optionally

Summary of the course: The purpose of studying course a is to consider the main ways to clean the air from greenhouse gases. Performing technological calculations for the purification of greenhouse gases in an industrial conditions.

Prerequisites for this course: Couse «Climate engineering technologies».

Competences:

– The ability to solve complex problems and problems in the field of ecology, environmental protection and balanced natural resource management in the implementation of professional activities or in the learning process, involves research and / or innovation, and is characterized by the complexity and uncertainty of conditions and requirements.

– The ability to communicate professionally and translate environmental information from foreign sources.

Skills in the use of environmental technologies to minimize the technogenic impact on natural systems.

– Knowledge of the factors of impact of environmentally hazardous phenomena and processes on biological and physiological indicators of a person's state, the ability to apply them to determine the social consequences of technogenic changes in the state of the environment.

– The ability to organize work related to the assessment of the ecological state, environmental protection and optimization of nature management in conditions of incomplete information and conflicting requirements.

– The ability to develop and implement a set of works on climate change prevention, adaptation and mitigation of consequences.

Learning outcomes:

– Demonstrate awareness of the latest principles and methods of environmental protection.

– Analyze and diagnose crisis processes affecting the biological and physiological indicators of a person's state for forecasting, planning, preparing for their prevention.

List of lecture topics:

1. Greenhouse gas classification.
2. Basic approaches to removing carbon from the atmosphere.
3. Carbon capture and storage technologies.
4. Methods for the disposal of waste nitrous gases.
5. Utilization of heat and condensate of steam emissions.

List of practical classes, including laboratories, studios and workshops:

1. Capturing carbon dioxide in power plants.
2. Purification of gases from nitrogen oxides.
3. Schematic integrated solutions to the problem of utilization of steam emissions.
4. Utilization of energetically valuable process gases (coke oven, blast furnace, converter and ferroalloy) of the steel production process.

List of self-study topics:

1. Greenhouse activity of ozone.
2. Fluctuations in the concentration of methane in the environment.
3. The main technologies for capturing, storing and using carbon.
4. Decarbonization of the oil and gas industry.