APPROVED
Director of the Institute
of Non-Destructive Testing
_____ Borikov V.N.

"_____"_____ 2014 г.

COURSE SYLLABUS
ECOLOGY

STUDY MAJOR: 150700 Mechanical Engineering
QUALIFICATION (DEGREE) **Bachelor**
Admission of 2013 year
YEAR 2 SEMESTER 3
CREDITS 2
DISCIPLINE CODE (ДИСЦ. Б2. Б2)

FORM OF STUDY	**STUDY TIME ALLOCATION:**
	150700 Mechanical Engineering
LECTURES, h	16
PRACTICAL CLASSES, h	16
LABORATORY WORKS, h	-
CLASS HOURS, h	32
SELF-STUDY, h	40
TOTAL, h	72

FINAL ASSESSMENT Final Test

DEPARTMENT Ecology and Basic Safety

HEAD OF DEPARTMENT _____S.V. Romanenko

LECTURER _____O.B. Nazarenko

2014

1. Course objectives

The main objective of the discipline "Ecology" is the formation of students' of ecological worldview and the ability to use environmental laws and principles for making the design decisions in their professional activities.

The course is aimed at training of bachelors to:

- the research and technological work in the professional field related to the control of environmental safety works, development of low-waste, energy-saving and environmentally friendly technologies,
- the search and analysis of the main scientific and technical information needed to solve specific engineering problems, including the implementation of interdisciplinary projects.

2. The rank of the course in the educational program structure

The course "Ecology" refers to the basic part of the mathematical and natural science cycle.

Prerequisites: None.

Discipline "Ecology" forms at students a basic understanding of the world and the processes occurring in living systems, provides a framework for the conduct of professional activities with taking into account environmental requirements.

The results of studying the discipline can be used when writing a creative project, performing educational research and the thesis.

3. Student Learning Outcomes (Results)

In accordance with the requirements of the General Educational Program (GEP) the study of subjects (modules) is aimed on formation at the students the following competencies (learning outcomes):

Table 1

Components of the learning outcomes to be obtained in the study of the discipline

Learning Outcomes (Competencies)	Components of the learning outcomes					
	Code	Knowledge	Code	Skills	Code	Competencies
R1. Ability to apply basic and specialized knowledge in the field of mathematics, natural, human and economic sciences in the complex engineering activities on the basis of an integrated system of scientific knowledge about the world.	K1.1	Basic math, physical, social and economic laws and regulations as a combination of an integrated system of scientific knowledge about the world;	S1.1	To apply the basic and specialized knowledge in the area of mathematics, natural, human and economic sciences in complex	C1.1	The skills of application of the basic and specialized knowledge in the mathematical, natural, human and economic sciences in

				engineering activities;		complex engineering activities;
	K1.2	The basic principles of the use of natural resources, energy and materials as sources of human life	S1.2	To apply the principles of natural resources, energy and materials as sources of human activity in the complex engineering activities	C1.2	The experience in the application of the principles of natural resources, energy and materials as sources of human activity in the complex engineering activities
R7. The ability to use the basic laws of the natural sciences, methods of mathematical analysis and simulation, the foundations of theoretical and experimental research in complex engineering activities in order to model the objects and processes in engineering	K7.1	The basic laws of natural sciences	S7.1	To use the basic laws of the natural sciences in the design of engineering products and technologies for their production	C7.1	The skills of the using the basic laws of the natural sciences in the design of engineering products and technologies for their production
R14. The ability to participate in the work on innovative projects using basic techniques of research, based on a systematic study of the scientific and technical information, domestic and foreign experience, conducting patent research.	K14.1	The methods of bibliographic search of scientific and technical information	S14.1	To make analytical reviews on scientific and technical topics	C14.1	The skills in the use of analytical review of the scientific and technical subjects at work on innovative projects
R15. Ability to apply modern methods for the development of low-waste, energy-saving and environmentally friendly engineering technologies to ensure the safety of life of people and to protect them from the consequences of accidents, and natural disasters, the ability to apply the methods of rational use of raw materials, energy and other resources in engineering.	K15.1	The world's major trends in the development of low-waste, energy-saving and environmentally friendly engineering technologies	S15.1	To apply modern methods for the development of low-waste, energy-saving and environmentally friendly engineering technologies		

As a result of the development of the discipline "Ecology" a student must have achieved the following results:

Table 2

Planned results of studying the discipline

№	Result
RD1	Knowledge of the problems of the world civilization interaction with nature and the ways of their reasonable solution
RD2	Knowledge of the basic mechanisms of the functioning of the biosphere
RD3	The application of ecological principles of nature protection and environmental management
RD4	Knowledge of the basics of human ecology
RD5	Knowledge of global and local environmental problems, types of protective equipment and technology
RD6	Knowledge of organizational and legal means to protect the environment
RD7	Using the basic laws of ecology in professional activities
RD8	The ability to choose the technical means and technologies, taking into account the environmental impacts of their use
RD9	Predicting the consequences of their professional activities in terms of biospheric processes
RD10	Knowledge of methods of choosing the rational way to reduce the impact on environment in the professional activity

4. Course structure and content

4.1 Course content

The Lecture material is composed of the following sections:

1. Introduction. The problems of interaction between society and nature

What is ecology? Haeckel's definition. History of Ecology. Ecological organization. Hierarchy. Levels of organization. Main forms of ecology (synecology, autecology, demecology). Modern ecology as a multidisciplinary science. The stages of interaction of human society and nature. The ecological disasters and their causes. The modern ecological crisis. The ways out of the ecological crisis.

2. Biosphere

What is the biosphere? Structure and boundaries of the biosphere. Autotrophic and heterotrophic organisms. Producers, consumers, decomposers. Energy flow in ecosystems. The concept of the biosphere of V.I. Vernadsky. Evolution of the biosphere.

3. Organisms and environment

Living organism as a holistic system. Habitat. Ecological factors. Abiotic and biotic factors. Regularities of ecological factors. Biodiversity. Limiting

factors. Law of the Minimum. Law of Tolerance. Adaptation. Ecological niche. Concept of ecological niche. Fundamental niche and realized niche.

Populations. Definition of population. Population parameters. Population growth. Limitations to population growth. Environmental resistance. Carrying capacity. Selected models of population growth: exponential growth; sigmoid (logistic) growth.

Properties of biological communities. Organism relationships. Feeding relationships. Interactions between species. Competition. Competition. Parasitism. Mutualism. Amensalism and Commensalism.

4. Ecosystems

Ecosystem definition. Ecosystem structure. Types of ecosystem. Ecosystem function. Stability of ecosystems. Homeostasis. Ecological succession. Types of succession. Primary production, secondary production. Food chains. Food web. Trophic levels. Transfer of energy across trophic levels. Ecological pyramids. Three types of ecological pyramids. Biogeochemical cycles. Human action on biogeochemical cycles. Biomes. Physical, climatic and biological characteristics of the main terrestrial biomes.

5. Human populations

Patterns of growth of the human population. Birth and death rates. Crude birth and death rates. Fertility. Age-gender structure of populations. Population growth in less developed countries (LDCs). Population growth in more developed countries (MDCs). Demographic transition. Family planning. Emigration. Immigration. The problems of nutrition and food production. Environment and human health.

6. Natural resources and associated problems

Natural resources. Classification. Renewable and non-renewable natural resources. Degradation and depletion of natural resources.

Exploitation of natural resources. Biotic resources. Harvesting of biotic resources: logging; grazing; hunting and fishing, the trade of exotic species for various reasons. Reduction of biodiversity. Sustainable agricultural practices. Abiotic resources. Extraction and use of abiotic resources. Soil erosion and desertification. Major causes. Major impacts.

Environmental impacts: loss of land and habitat; subsidence and flooding; air and water pollution; hazards of nuclear energy use.

Conservation biology. Tools used in conservation biology Protecting the natural environment by establishing protected areas. Legislative tools.

7. Atmospheric pollution

Nature of pollutants. Pollution. Pollutant. General characteristics of sources of pollution. Natural and anthropogenic sources. Atmospheric pollution.

Acid rain. The major acid rain producing substances. The direct and indirect consequences of acid rains.

Global climate change. Causes and rates of natural climate change. Solar activity and volcanic activity. Global climate change as a consequence of atmospheric pollution. Greenhouse gases. Sources of greenhouse gases. Consequences of global warming.

Stratospheric ozone layer. Ozone depletion. Ozone depleting gases.

Smog. Smog formation and composition. Damages caused by smog.

Reduction and control of air pollution. International agreements that has helped to reduce pollution: Kyoto Protocol, Montreal Protocol, Convention on Transboundary Air Pollution.

Means for protecting the atmosphere. Apparatus for treating gas emissions from aerosols. Methods for cleaning up gas emissions from steam and gaseous contaminants.

8. Water pollution. Solid waste

Water resources. Fundamental properties of water. Hydrosphere structure. Water pollution. Specific water pollution issues. Thermal pollution. Acid drainage, mines and acid rain. Toxic metal pollution. Nitrate, phosphate and organic pollution. Sewage treatment. Methods of wastewater treatment: mechanical, physico-chemical and biological methods. Advanced water treatment technology.

Solid waste and its management. Types and sources of solid waste. Sources of waste production: municipal, industrial, agricultural, mining. Properties of substances found in the waste: mobility, toxicity, degradability, hazardous nature. Control of solid waste .The waste management hierarchy: reduce, reuse and recycle. Methods of solid waste treatment.Recycling.

4.2 Course structure

The course consists of eight sections based on a single theme. Table 3 outlines the sections, learning activities and study time allocation.

Table3

Structure of discipline on sections and forms of the organization of training

The name of the unit	Total contact hours		Self-Study Hours	Total Hours
	Lectures	Practical classes		
1. Introduction. The problems of interaction between society and nature	2	2	4	8
2. Biosphere	2	2	4	8
3. Organisms and environment	2	2	4	8
4. Ecosystems	2	2	4	8
5. Human populations	2	2	6	10
6. Natural resources and associated problems	2	2	6	10
7. Atmospheric pollution	2	2	6	10
8. Water pollution. Solid waste	2	2	6	10
Total	16	16	40	72

4.3 Distribution of competencies according to the course sections

Student outcomes articulated by the General Educational Program are given in Table 4.

Table 4

Distribution of intended learning outcomes within the divisions of discipline

№	Competences *	The name of the unit							
		1	2	3	4	5	6	7	8
1	K1.1		+	+	+				
2	K1.2	+				+	+		
3	K7.1	+					+	+	+
4	K14.1	+	+	+	+	+	+	+	+
5	K15.1						+	+	+
6	S1.1		+	+	+				
7	S1.2	+				+			
8	S7.1	+					+	+	+
9	S14.1	+				+	+	+	+
10	S15.1						+	+	+
11	C1.1		+	+	+				
12	C1.2	+				+			
13	C7.1	+					+	+	+
14	C14.1	+				+	+	+	+

* K – knowledge, S – skills, C – competencies

5. Educational technologies

The combination of educational technologies, given in Table 5, provides achievement of the expected outcomes (results).

Table 5

Teaching methods and learning forms

Methods	*Learning forms*		
	Lectures	Practical classes	Self-Study
IT- Methods	+	+	+
Teamwork		+	
Experience-based learning		+	
Advanced self-study			+
Search	+	+	+
Investigation		+	+

6. Self-study program

6.1 Current self-study

Current self-study is aimed at deepening student's knowledge, developing practical skills. It includes studying theoretical and lecture material, the study of

topics for self-training, preparing for practical classes research, completing individual works, tests and examination.

The topics that are proposed for the self-training are the following:

1. Environmental disasters and their causes
2. The problems of nutrition and food production
3. Modern water treatment technology
4. The concept of sustainable development
5. International organizations for the protection of the environment
6. Alternative sources of energy

6.2 Creative problem-oriented autonomous work

Creative problem-oriented autonomous work is aimed at developing intellectual skills, common cultural and professional competencies through participation in scientific student's conferences, completion of individual calculation tasks, searching, analyzing, structuring and presenting information on a specific topic of scientific review and preparing the essay.

The scientific review can focus on any of the topics in ecology covered during the course. The possible topics are presented in the list below.

Topics of scientific review

1. History of science "Ecology"
2. Biogeochemical cycles: carbon, nitrogen, oxygen
3. Demographic problems of the Earth
4. Problem of food product
5. Ecological consequences of forest fires
6. Fertilizers: benefits and harms
7. Ozone hole. Solutions to the problem
8. Acid rains
9. International agreements: Kyoto Protocol, Montreal Protocol
10. Global warming
11. Smog: formation and composition
12. Ecological problems of automobiles
13. Recycling
14. Low-waste technologies
15. Biotechnological processes in water treatment
16. Nuclear power engineering and the environment
17. Hydropower engineering and the environment
18. Thermal engineering and the environment
19. Alternative energy sources
20. Environmental consequences of industrial accidents

The students are required to write a 9-12 page typed review (single-spaced, 12 pt. font). The paper must review a minimum of three recent references from the primary literature (i.e., peer-reviewed scientific journals). The report should be well organized with a clear writing style; a thoughtful analysis of the problem should be included. The report should be divided into the main sections: Introduction, Main Part/Discussion, Conclusion, References, though further division into sub-sections may be appropriate.

The students are expected to prepare two essays.

Topics of essay

1. 'Ecology in my future professional activity'
2. The students are expected to choose the type of the second essay:
   2.1. 'TPU scientific development to protect the environment'
   2.2. 'Ecological problems of my country'

Students are required to write a 2-3 page typed essay (single-spaced, 12 pt. font).

6.3 Self-study assessment

The assessment of self-study results is organized as synthesis of two forms: self-check and teacher's control (at lectures, practical classes, examinations).

The defense of the scientific report and essays is carried out in conference-weeks and evaluated by both teachers and students. Evaluation of the scientific report and essay includes an assessment of the content and design of the presentation, the answers to questions.

7. Current and final assessment

Assessment of the quality of studying the discipline is made through the following control measures:

Table 6

Rated learning activity	Result
Questioning of students during practical classes to identify the knowledge and understanding of theoretical material	RD-1; RD-2; RD-3; RD-4; RD-5; RD-6
Essay	RD-5; RD-6; RD-7; RD-9; RD-10
Presentations of the scientific review at conference-week	RD-5; RD-6; RD-7
Active participation in scientific discussion	RD-3; RD-8; RD-9; RD-10
Control work	RD-1; RD-2; RD-4; RD-5; RD-8; RD-10

Final Test	RD-1; RD-2; RD-4; RD-5; RD-8; RD-10

To assess the quality of the studying the discipline at carrying out of control measures following means are provided.

Current assessment. During a semester, tests are carried out after completion of each course section. Aim is to measure the level of the theoretical and practical knowledge, and attained skills.

Individual tasks: essays and scientific review.

Final control: in the form of the final test.

Control questions for practical classes

1. How would you define the biosphere?
2. What levels of biological organization in nature are of particular interest for ecology?
3. What is an ecosystem?
4. What is the community?
5. What are the two methods by which autotrophs produce food?
6. When did the first living cells appear on our planet?
7. What is the difference between ozone and oxygen?
8. What is an ecological niche?
9. What is one difference between primary and secondary succession?
10. Why are energy pyramids always larger at the bottom than at the top?
11. What are the main characteristics of any population?
12. What is the difference between a population and a community?
13. What does the term "acid rain" mean?
14. Which gases cause acid rain?
15. How does acid rain form?
16. How does acid rain affect plants, lakes and soil?
17. What is the main problem with air pollution?
18. What factors affect ozone concentrations in the atmosphere?
19. What factors are changing the global climate?
20. What are the alternative sources of energy?
21. What are the advantages and the disadvantages of nuclear power?
22. What are the main sources of soil pollution?
23. What are the consequences of the use of chemical fertilizers?
24. What materials can be recycled?
25. What major factor has increased the intensity and scale of the biosphere transformations over the past two centuries?

Examples of tests to assess the theoretical knowledge of students:

1. The science dealing with interactions among and between organisms and their environment is called:
   a) ecology
   b) economy
   c) biology
   d) environmentalism
2. Arrange the levels of organization from largest to smallest:
   a) ecosystem, biome, biosphere, community, population
   b) biome, biosphere, community, ecosystem, population
   c) biosphere, biome, community, population, ecosystem
   d) biosphere, biome, ecosystem, community, population
3. Which of these is the sphere where you can find all the plants and animals on the earth?
   a) lithosphere
   b) stratosphere
   c) biosphere
   d) atmosphere
4. All of the members of a particular species that live in one area are called:
   a) biome
   b) population
   c) ecosystem
   d) community
5. What are organisms called that make their own food with sunlight or chemical energy?
   a) producers
   b) consumers
   c) decomposers
   d) scavengers
6. What is the original source of almost all the energy in most ecosystems?
   a) water
   b) nitrogen
   c) carbon
   d) sunlight
7. Which of the following is an abiotic factor in an ecosystem?
   a) tree
   b) rock
   c) bird
   d) fish
8. An interaction in which one organism captures and feeds on another organism is called

a) predation
b) mutualism
c) competition
d) commensalism

9. What is the term for each step in the transfer of energy and matter within a food web?
   a) food chain
   b) energy path
   c) trophic level
   d) food pyramid
10. The amount of energy that is passed from one organism to the next in a food chain is
   a) 5 %
   b) 10 %
   c) 15 %
   d) 20 %
11. The number of trophic levels in an ecological pyramid
   a) is limitless
   b) is limited by the amount of energy that is lost at each trophic level.
   c) never exceeds two.
   d) never exceeds three
12. Most climate models predict that during this century, the average temperature
   a) on land will increase, and the average ocean temperatures will decrease
   b) on land will increase, as will the average ocean temperatures
   c) on land will decrease, and the average ocean temperatures will increase
   d) on land will decrease, as will the average ocean temperatures

Examples of tasks for the assessment of practical skills:

Task 1. Small farming community in Tomsk region covers 10 square kilometers. There are 400 individuals who live within the village limits. What is the population density of this community?

Task 2. Calculate the approximate mass of the oxygen generated in the world as a result of photosynthesis. Assume that the current forests occupy about 20 % of the land, and agricultural land – 50 % of the remaining part of the land. Sea plants produce half of the oxygen generated in the world.

The surface area of the Earth $S_E = 510{,}2 \cdot 10^6$ km^2 = $510{,}2 \cdot 10^8$ ha; 1 ha = 10000 m^2; $S_{land} = 30\ \% S_E$.

1 hectare of forest provides oxygen $К_{forest} = 23$ tons/years, 1ha of farmland – $К_{fl} = 5$ tons/years.

Final Test Sample

The examination card № 1

Discipline: Ecology
Study major: 150700 Mechanical Engineering
Semester: 3

1. ***What is the science dealing with interactions among and between organisms and their environment?*** *(5 points)*
   a) Ecology
   b) Economy
   c) Biology
   d) Environmentalism

2. ***Why are producers an essential component of an ecosystem?*** *(5 points)*

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3. ***What is one difference between primary and secondary succession?*** *(5 points)*
   a) Primary succession is slow and secondary succession is rapid.
   b) Primary succession modifies the environment and secondary succession does not.
   c) Secondary succession begins with lichens and primary succession begins with trees.
   d) Secondary succession begins on soil and primary succession begins on newly exposed surfaces.

4. ***Why the number of trophic levels in an ecological pyramid is limited?*** *(5 points)*

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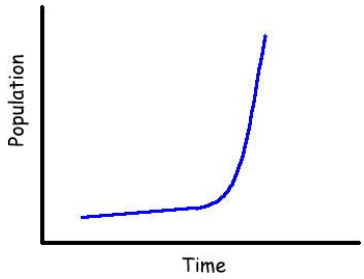

5. ***The growth curve is an example of …*** *(5 points)*
   a) logistic growth
   b) predator-prey relationship
   c) exponential growth
   d) extinction

6. ***Population of elks in Tomsk region covers 100 square kilometers. There are 1200 individuals who live within this area. What is the population density of elks?*** *(10 points)*

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7. ***Deforestation has the effect of …*** *(multiple answer)* *(5 points)*
   a) contributing to global warming
   b) increasing atmospheric CO_2
   c) increasing atmospheric oxygen, O_2
   d) increasing soil loss through erosion
   e) decreasing biodiversity

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Lecturer _____/ O.B. Nazarenko
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Head of department _____/ G.V. Kashkan
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8. References

Basic (B)

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2. Encyclopedia of Environmental Science and Engineering / ed. J.R. Pfafflina, E.N. Zieglera. 5th ed. New York: Taylor & Francis, 2006.
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Additional (A)

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2. Restoration Ecology and Sustainable Development / K.M. Urbanska, N.R. Webb, P.J. Edwards. New York: Cambridge University Press, 2000. 397 p.
3. Restoration Ecology. The New Frontier / ed. J. Andel van, J. Aronson. 2nd ed. Chichester: Wiley-Blackwell, 2012. 381 p.

Web sources

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2. http://regentsprep.org/Regents/biology/units/ecology/biotic.cfm
3. http://www.worldometers.info/world-population/
4. http://www.globalchange.umich.edu/globalchange2/current/lectures/human_pop/human_pop.html
5. http://www.exploratorium.edu/climate/
6. http://www.recyclenow.com/
7. http://www.waterworld.com/technologies.html

9. Facilities

№	The name (educational audiences, computer classes, the equipment)	Building - Room
1	Educational audience, projector	19 - 443
2	Educational audience, projector	8 - 102

The syllabus is drawn on the basis of State Educational Standard for international students following the major 150700 Mechanical Engineering

Author:

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