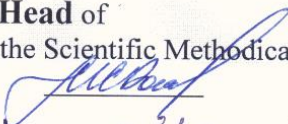


Ministry of Education and Science of Ukraine  
M.Ye. Zhukovsky National Aerospace University  
"Kharkiv Aviation Institute"

Department of Public Administration and Entrepreneurship (601)

Head of  
the Scientific Methodical Commission №1  
 Romanov M.

« 31 » 08 2021

**WORK PROGRAM FOR NORMATIVE ACADEMIC DISCIPLINE**

**Chemistry and Fundamentals of Ecology**

(code and name of the course)

**Area of study:**

13 «Mechanical Engineering»

(area code and name)

27 « Transport »

(area code and name)

**Major:**

6.134 «Aviation and Aerospace Engineering»

(major code and name)

6.272 « Aviation transport »

(major code and name)

**Educational program:**

Airplanes and helicopters

(name of educational program)

Maintenance and repair of aircraft and aircraft engines

(name of educational program)

Technology for the production and repair of aircraft

(name of educational program)

Operational diagnostics maintenance and repair of aircraft engines and power plants

(name of educational program)

**Form of study: full-time**

**Higher education level: first (Bachelor)**

Kharkiv 2021

Work program for academic discipline « Chemistry and Fundamentals of Ecology»  
for students of **major:**

6.134 «Aviation and Aerospace Engineering»

6.272 « Aviation transport »


27 August, 2021, 11 p.

Author:

Department 601 Senior Lecturer  Seredenko V.

Work program for academic discipline was approved at the faculty meeting at the  
Department of Public Administration and Entrepreneurship (601)

Protocol № 1 from “28” August 2021

Chairman of the Department of Public Administration and Entrepreneurship (601),  
Doctor of Science in Public Administration,  
professor  Kovalchuk V.

## 1. Academic discipline description

Name of characteristic	Area of knowledge, major, educational qualification level	Academic discipline characteristic <i>Form of study: full-time</i>
Number of credits – 3	<b>Area of knowledge</b> <u>13«MechanicalEngineering»</u>	General training cycle
Modules – 2	<u>27 « Transport »</u> (code and name)	<b>Academic year:</b>
Content modules – 2	<b>Major</b> <u>6.134 «Aviation and</u>	2020/2021
Individual scientific-research assignment (essay)	<u>Aerospace Engineering»</u> <u>6.272 « Aviation transport »</u> (major code and name)	<b>Semester</b>
General number of hours: number of hours of classes - 40 hours. / Total number of hours - 90 hours	<b>Educational program</b> <u>Airplanes and helicopters</u> <u>Maintenance and repair of aircraft and aircraft engines</u> <u>Technology for the production and repair of aircraft</u> <u>Operational diagnostics maintenance and repair of aircraft engines and power plants</u> (name of educational program)	<b>1<sup>th</sup> or 2<sup>th</sup></b>
Weekly hours for daytime education: class – 2,5; self-study – 3,125	<b>Educational qualification level:</b> <u>Bachelor</u>	<b>Lectures</b>  16 h.
		<b>Practical lessons</b>  24 h.
		<b>Self-study</b>  50 h.
		<b>Type of control</b>
		modular control, credit

### Note

The relation between the number of class hours and the number of self-study hours makes up: 40 / 50 h.

\* The classroom load may be reduced or increased by one hour depending on the class schedule.

## 2. Aim and tasks of the educational discipline

**The aim** is to teach students to the major laws of physical-chemical processes used in the design, manufacture and operation of various construction materials, fuels and flying apparatus engines; to familiarize students with Science of Ecology, its main purposes and methods of investigations.

**The tasks** are to give students the knowledge of the most important (for their major) parts of Chemistry, basic knowledge of Ecology and Environment, experience of doing chemical experiments and obtaining some definite parameters of chemical processes.

In result of study the educational discipline students **must**

**know:**

- Laws, describing the dependence of properties of substances by their chemical composition and structure of atoms and molecules, structure and reactivity of combustible fuels used in the AST.
- General thermodynamic and kinetic rules of chemical processes in the AST.
- Physical and chemical properties of metals, alloys, polymers as structural materials;
- Optimal parameters of chemical processes in the fuel systems of AST.
- Corrosion and methods to protect metals and alloys from corrosion; influence of environmental parameters and processes on the intensity of corrosion.
- The major forms and sources of pollution

**be able to:**

- determine the properties of elements and compounds based on the periodic law of D. I. Mendeleev;
- evaluate the properties of compounds, knowing the types of chemical bonds in molecules of gases, liquids and crystals;
- choose the most effective parameters of processes;
- evaluate the corrosion resistance of materials under certain operating conditions and to choose the best methods of protection against corrosion;
- pick up the necessary materials for the process under the given parameters.

**General and professional competencies:**

- skills to carry out safe activities, the desire to preserve the environment;
- ability to work in a team;
- ability to make informed decisions;
- ability to learn and master modern knowledge;
- ability to assign optimal materials for aircraft structural elements.

**Programmed results**

- Describe the structure of metals and non-metals and know the methods of modifying their properties. Assign optimal materials for elements and systems of aircraft, taking into account their structure, physical, mechanical, chemical and operational properties, as well as economic factors.
- Explain their decisions and the reasons for their adoption to specialists and non-specialists in a clear and unambiguous form.

**Prerequisites:** Chemistry (school program).

**Corequisites:** Materials Science. Thermodynamics and Heat Transfer

### 3. Program of academic discipline

#### Module 1.

**Content module 1.** Introduction to the Course. Chemical thermodynamic Chemical kinetics

##### **Topic 1. Introduction to the Course. Chemical Thermodynamics. Basic notions and definitions. First Law of Thermodynamics.**

Chemistry as a subject to study. Role of Chemistry in Design, Manufacturing and Using of Airplanes and Rockets. Structure of the Course.

The properties of elements and compounds based on the periodic law of D. I. Mendeleev. The types of chemical bonds in molecules of gases, liquids and crystals.

Thermochemistry. Internal Energy and Enthalpy and Other Basic Concepts: a System, a Closed System, an Isolated System. Processes (isobaric, isochoric, isothermal, adiabatic), Parameters, and Functions of State.

Heat Effects of Chemical Reactions. Heat Effect of Formation (Combustion). Hess' Law, its Consequences. Efficiency of Fuel. Dependence of the Heat Effect of Reaction on Temperature, Kirhgoff's Law.

##### **Topic 2. Second law of Thermodynamics.**

Entropy, Its Physical, Statistical and Thermodynamical Sense. Third Law of Thermodynamics. Change of Entropy in Spontaneous Processes and Chemical Reactions. The Maximum and Maximum Useful Work in a Process. Gibbs Energy and Helmholtz Energy as Measures of Stability of Substances and of Direction of a Reaction.

##### **Topic 3. Chemical Kinetics.**

Kinetic Classification of Chemical Reactions. Factors Influencing Rate of a Reaction. Dependence of Reaction Rate on Concentration of Reactants. Half-life of the reactions Dependence of Reaction Rate on Temperature. Van-Hoff Rule. Arrhenius Equation. Energy of Activation, Methods of its Determination. Zero and First Order Reactions. Reaction Mechanism. Complex reactions.

##### **Topic 4. Chemical Equilibriums. Kinetics and Mechanisms of Reactions**

Chemical Equilibriums in Heterogeneous and Homogeneous systems. Equilibrium Constant. Partial Pressure of a gas. Le Chatelier's Principle as Method of Optimization of Conditions of Technological Processes.

Diffusion and Adsorption. Physical and Chemical Adsorption. Heterogeneous Reactions Features and Mechanisms of Homogeneous and Heterogeneous Catalysis. Mechanism of Free Radical Processes. Chain Reactions and Their Kinetics. Photochemical Reactions and their Kinetics.

**Modular control** - execution of control-module work No. 1

**Content module 2** Electrochemistry and Corrosion. Basics of Ecology.

##### **Topic 5. Electrochemistry. Practical Application of Electrochemical Processes**

Double Electric Layer and Potential Jump. Measurement of Electrode Potential. Standard Electrode Potentials and Electromotive (force) Series. Galvanic Cell. Electromotive Force of a Galvanic Cell. Polarization.

Chemical Sources of Energy: galvanic cells, accumulators, fuel cells. Quantitative Laws of Electrolysis. Chemical Reactions in Electrolysis of Salts and Molten Electrolytes. Practical Application of Electrolysis.

**Topic 6. Chemical and Electrochemical Corrosion of Metals and Alloys.**

Types of Corrosion Destruction. Thermodynamics of Corrosion. Kinetics of Corrosion. Mechanism of Chemical and Electrochemical Corrosion. Oxygen and Hydrogen Depolarization.

**Topic 7. Main Protection of Metals and Alloys Against Corrosion.**

Classification of Metals according their Resistance against Corrosion. Coatings and Methods of their Obtaining. Anti-Corrosive Treatment of Medium. Inhibitors of Corrosion. Electrochemical and Chemical Methods of Obtaining of Protecting Coatings. Design Principles that reduce corrosion.

**Topic 8. Familiarity with the Basics of Environmental Knowledge.**

Acquisition of Basics Knowledge of Science of Ecology and Environment. Purposes of Ecology and its Methods of Investigation. Ecosystem. The major form of Pollution. Sources of pollution. Threshold Limit Value. Pollution in Aviation and Rocket Industry.

**Modular control 2** - execution of control-module work No. 2.

**Module 3.**

Individual assignment (essay writing)

**4. Structure of academic discipline**

Topics for content modules and units	Number of hours				
	total	including			
		L	P	lab	ind.
1	2	3	4	5	6
<b>Module 1.</b>					
<b>Module 1 contents.</b>					
Topic 1. Introduction to the Course. Structure of matter. The chemical bond. Chemical Thermodynamics, its Basic Concepts. First Law of Thermodynamics. Hess' Law.	26	2	-	6	18
Topic 2. Second law of Thermodynamics. Entropy. Third Law of Thermodynamics.	6	2	-	-	4
Topic 3. Chemical kinetics.	9	3	-	4	2
Topic 4. Chemical Equilibriums. Kinetics and Mechanisms of Reactions	5	1	-	-	4
Module control 1				2	
<b>Total in module 1</b>	<b>46</b>	<b>8</b>	<b>-</b>	<b>12</b>	<b>28</b>
<b>Module 2 contents.</b>					
Topic 5. Electrochemistry. Practical Application of Electrochemical Processes	9	3	-	2	2
Topic 6. Chemical and Electrochemical Corrosion of Metals and Alloys	8	2	-	2	2
Topic 7. Main Protection of Metals and Alloys Against Corrosion	8	2	-	2	2

Topic 8. Familiarity with the Basics of Environmental Knowledge	21	1	-	4	6
Module control 2	-	-	-	2	-
<b>Total in module 2</b>	<b>34</b>	<b>8</b>	<b>-</b>	<b>12</b>	<b>12</b>
<b>Module 3.</b>					
Individual assignment (essay writing)	10				10
Control measure (credit)					
<b>Hours total</b>	<b>90</b>	<b>16</b>	<b>-</b>	<b>24</b>	<b>50</b>

**5. Topics for seminars and practical lessons**  
(no curriculum is provided)

№	Name	Num. of hours
1.		

**6. Topics for practical lessons**  
(no curriculum is provided)

№	Name	Num. of hours
1		

**7. Topics for laboratory lessons**

№	Name	Num. of hours
1	Safety rules when working in the chemical laboratory.	2
2	Chemical equipment. Determination of heat effect of the reaction of neutralization of monobasic acid by alkali	4
2	Rate of a homogeneous chemical reaction	4
3	Hardness of water	2
4	Measurement of acidity of solutions and hydrolysis of salts	2
5	Galvanic cell	2
6	Corrosion of metals and alloys. Protection of metals and alloys against corrosion	6
	<b>Total</b>	<b>24</b>

**8. Self-study**

№	Name	Num. of hours
1	Role of Chemistry in Design, Manufacturing and Using of Airplanes and Rockets	2
2	Internal Energy of the system. Isobaric, Isochoric, Isothermal and Adiabatic Processes	4
3	Physical, Statistical and Thermodynamical Sense of Entropy. Dependence of Thermodynamical potentials on Temperature.	6
4	Examples of different order reactions. Physical sense of Rate constants of the reactions. Half-life of the reactions.	1
5	Kinetic classification of reactions. Complex reactions: reversible, simultaneous, consecutive and conjugate ones.	2
6	Free Radical Processes. Chain Reactions. Photochemical Reactions.	2
7	Diffusion and kinetic factors in chemical kinetic. Diffusion in gases, liquids and solid substances.	1

8	Examples of chemical current sources: galvanic cells, accumulators, fuel cells. Usage of fuel cells in aero-space technique.	2
9	Protection metals and alloys against corrosion in aero-space technique. Corrosion resistance and methods of protection of metals and alloys against corrosion.	4
10	Pollution in Aviation and Rocket Industry. Methods of decreasing of its harmful effect.	16
11	Structure of matter. The chemical bond. The types of chemical bond. The dependence the properties of substances from type of bond	10
	<b>Total</b>	<b>50</b>

### 9. Individual tasks

Individual task in the course of “Chemistry and Fundamentals of Ecology” is done by the students themselves and under the guidance of the instructor.

Individual work involves the preparation of the essay, solving problems.

#### Topics of essays

1. Technogenic dispersion of matter. The peculiarity of this phenomenon in physics, chemistry, biology, geography.
2. Ways of development of alternative energy.
3. Classification of environmental self-cleaning processes.
4. Acid deposition: origin. Ecological harm. Methods of prevention and rehabilitation.
5. Technological activities of mankind and its impact on the state of water resources.
6. The problem of technogenic dispersion of heavy metals. Analysis, biological effects and prevention.
7. The second law of thermodynamics and its reflection in the phenomena and processes occurring in "living matter".
8. Technogenic dispersion of matter in the biosphere in the light of the laws of transport phenomena.
9. “Soil fertility” in the system of representations of the physical chemistry of heterogeneous systems (adsorption and ion exchange).
10. Mathematical modeling of processes and phenomena in ecosystems (system-organized relationships and laws of nature).
11. Anthropocentrism and ecocentrism: two strategies of "dialogue with Nature", their essence, assessment and future.
12. Rational nature management and environmental protection in the light of environmental laws.
13. Biogeocenoses as “machines” transforming matter and energy on Earth: a scientific interpretation of this image.
14. Constructive steps of mankind to prevent environmental disaster.
15. Radiation as an environmental factor (natural and man-made contributions).
16. The inevitability of human impacts on natural ecosystems: the "pros" and "cons" of the anthropogenic factor.
17. Anthropogenic pressure on the natural environment: classification of forms and species.
18. The problem of the “greenhouse effect”: environmental consequences and ways to prevent.
19. The problem of “acid rain”: sources of occurrence, environmental consequences, ways to prevent and rehabilitate subsystems of the biosphere.
20. The problem of technogenic scattering at the elemental and material levels.
21. Environmental monitoring: types, goals, methods. Organization.
22. The concept of risk associated with environmental management technology: sources, methods of assessment, ways to reduce and prevent.
23. The greening of technology: the meaning of the problem and ways of implementation.



24. Polyproduct technology as an ideal of optimized environmental management.
25. The principle of "sustainable development" (Rio de Janeiro, 1992) and its implementation in the modern technosphere.
26. Industrial waste and industrial formations: justification of the profitability of their disposal and disposal.
27. Advantages and disadvantages of modern synthetic detergents.
28. Waste-free recycling of paper waste.
29. Computer technology and environmental safety.
30. Motor transport and its impact on the environmental situation in urban areas.
31. Pollution of the sea by oil products.
32. Pesticides and chemical fertilizers.
33. The problem of desertification of the planet.
34. Types of environmental crises.
35. International environmental organizations.

### **10. Teaching methods**

For the sake of effective material learning the following teaching methods are used:

- explanatory and descriptive;
- method of schematic illustration of the subject matter in the form of diagrams, charts, graphs;
- situational method (solving and analysis of problems);
- reproductive;
- method of investigation.

### **11. Methods of progress control**

System of current knowledge control contains estimation of:

- systematic and active student participation during laboratory lessons;
- individual and self-study task accomplishment;
- final grading (fail/pass).

## **12. Assessment criteria and the distribution of points that students receive**

### **12.1 Distribution of points that students receive (exam)**

Components of study work	Points for one class (task)	Number of lessons	Total number of points
<b>Module I</b>			
<b>1. Participation during laboratory lessons and solving problems</b>	<b>0...5</b>	<b>5</b>	<b>0...25</b>
<b>Total module № 1</b>	<b>0...20</b>	<b>1</b>	<b>0...20</b>
<b>Module II</b>			
<b>1. Participation during laboratory lessons and solving problems</b>	<b>0...5</b>	<b>5</b>	<b>0...25</b>
<b>Total module № 2</b>	<b>0...20</b>	<b>1</b>	<b>0...20</b>
Individual assignment		<b>1</b>	<b>0...10</b>

<b>Total of discipline</b>			<b>0...100</b>
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The semester control (examination) is carried out in case of student's refusal of the points of the current testing and if there is admission to the credit. During the semester credit, the student can get a maximum of 100 points.

The credit card consists of two theoretical questions, with a maximum score of 50 points for each question, totalling 100 points.

## 12.2. Qualitative evaluation criteria

**The required amount of knowledge to receive a positive assessment:** as a result of studying the discipline Chemistry and Fundamentals of Ecology students should know:

- laws, describing the dependence of properties of substances by their chemical composition and structure of atoms and molecules, structure and reactivity of combustible fuels used in the AST;
- general thermodynamic and kinetic rules of chemical processes in the AST;
- physical and chemical properties of metals, alloys, polymers as structural materials;
- optimal parameters of chemical processes in the fuel systems of AST;
- corrosion and methods to protect metals and alloys from corrosion; influence of environmental parameters and processes on the intensity of corrosion;
- the major forms and sources of pollution

**The required amount of skills to receive a positive assessment:** as a result of studying the discipline students should be able to:

- determine the properties of elements and compounds based on the periodic law of D. I. Mendeleev;
- evaluate the properties of compounds, knowing the types of chemical bonds in molecules of gases, liquids and crystals;
- choose the most effective parameters of processes;
- evaluate the corrosion resistance of materials under certain operating conditions and to choose the best methods of protection against corrosion;
- pick up the necessary materials for the process under the given parameter.

## 12.3 Criteria for assessing student work during the semester:

The criteria for evaluating a student's work during the semester in the discipline of political economy are determined by grades "excellent", "good", "satisfactory", "unsatisfactory".

Excellent Score: 90-100 points are awarded under the following conditions:

- 1) creative approach to the learned material, completeness and correctness of the task;
- 2) ability to apply different principles and methods in specific situations;
- 3) in-depth analysis of facts and events, ability to predict results from decisions;
- 4) a clear, consistent presentation of the answer on paper;
- 5) the ability to link theory and practice.

Good Score: 75 - 89 points are subject to the following conditions:

- 1) there are some non-fundamental errors of insignificant nature in the presentation of the answers with full knowledge of the program material;
- 2) the predominance of logical approaches over creative in answering questions;
- 3) it is not always correct to predict events from the decisions made;

4) the ability to relate theory to practice.

Satisfactory Score 60 - 74 points are awarded under the following conditions:

- 1) a reproductive approach to learning and teaching material;
- 2) lack of completeness of teaching material;
- 3) shallow knowledge of the basic material, the presence of a large number of inaccuracies in the presentation of the material;
- 4) fuzzy teaching of material on paper, violation of logical sequence in the presentation of material.

Unsatisfactory Score: 1 - 59 points are subject to the following conditions:

- 1) lack of knowledge of most of the material, poor understanding of the basic principles of the course;
- 2) the presence of gross, fundamental errors in the performance of the tasks;
- 3) illiterate and incorrect presentation of answers on paper.

#### Evaluation scale: national and ECTS grade system

Sum of grades for all educational activities	ECTS grade	National grade	
		in exam, course project (paper), practice	for passed
90 - 100	A	excellent	pass
83 - 89	B	good	
75 – 82	C		
68 -74	D	satisfactory	
60 – 67	E		
1 – 59	FX	unsatisfactory with the opportunity of repeating an exam	fail with the opportunity of repeating the exam

### 13. Methodological guidelines

1. R. Holyst, A.Poniewierski. Thermodynamics for Chemists, Physicists and Engineer. Institute of Physical Chemistry Polish Academy of Sciences. Warsaw. Poland.- 343p.
2. Thermodynamics: a Core Course, 3<sup>rd</sup> ed., R.C.Srivastava, Subit Saha and Abhay K.Jain. – 2007,
3. Chemistry: A Modern Introduction for Sixth Forms and Colleges. Part 3 Physical Chemistry, T.F.Chadwick, BSc.
4. Josef P.Novak, Stanislav Labik, Ivana Maijevska. Physical Chemistry in Brief. Institute of Chemical Technology. Prague. September 30, 2005.

### 14. Recommended reading

#### Basic

1. Thermodynamics and Chemistry. Second Edition, Version 6, February 2015. University of Maryland. Copyright by Howard DeVoe.
2. Коваленко Д.Е. Конспект лекций по химии для студентов первого курса (in English) Харьков:Харьковский авиационный институт.1997-104с.
3. Коваленко Д.Є. Хімія: Лабораторний практикум (in English)/Д.Є.Коваленко-Х.:Нац.аерокосм.ун-т «Харк.авіац.ін-т».2009-Ч.1.-26с.

#### Additional

<https://www.epa.gov/environmental-topics>

1. <https://corrosion.ksc.nasa.gov/index.htm>

## **15. Informational resources**

Course in Mentor