Ministry of Education and Science of Ukraine
National Aerospace University
"Kharkiv Aviation Institute"

Department of "Composite Structures and Aviation Materials" № 403

APPROVED BY

Project group Leader/
Head of EMC
_____ M.A. Shevtsova
(signature) (initial and surname)
«____» _____ 2021

GRADUATING PROGRAM OF COMPULSORY EDUCATIONAL DISCIPLINE

Aviation Materials Science
(title of the discipline)

Branch of knowledge: 13 «Mechanical Engineering»
(code and title of brunch of knowledge)

Direction of qualification: 134 «Aerospace Engineering»
(code and title of specialty or direction of graduation)

Educational program: for all educational programs
(title of educational program)

Form of education: daily form of studying

Level of Higher Education: First (Bachelor)

Kharkiv 2021

Graduating program Aviation Materials Science
(title of the discipline)

For students of direction of qualification: 134 «Aerospace Engineering»

Educational program: Satellites, engines and power plants

«_27_» __08___ 2021, _11__ pages.

Developed by:

O.O. Vambol, ass. professor of 403 dept., Ph.D, associate professor _____
(surname and initials, position held, scientific rank, academic rank) (signature)

Program was approved by department of Composite Structures and Aviation Materials
(the department title)

Protocol № _1___ from «_28_» ____ 08 _____ 2021.

Head of department, Ph.D, professor _____ M.A. Shevtsova
(department title, head of department scientific rank and academic rank) (signature) (initial and surname)

1. Description of educational discipline

<table>
<tr><td rowspan="2">Indicators</td><td rowspan="2">Branch of knowledge, direction of qualification, educational program, level of education</td><td colspan="2">Characteristics of educational discipline</td></tr>
<tr><td>daily form of studying</td><td>external form of education</td></tr>
<tr><td>Credits – 5.5</td><td rowspan="11">Branch of knowledge
13 «Mechanical Engineering»
(code and title)

Direction of qualification
134 «Aerospace Engineering»
(code and title)

Educational program
Satellites, engines and power plants
(code and title)

Level of Higher Education:
First (Bachelor)</td><td colspan="2">General education cycle</td></tr>
<tr><td>Modules – 2</td><td colspan="2">Academic year</td></tr>
<tr><td>Substantial modules – 4</td><td colspan="2">2021/ 2022</td></tr>
<tr><td>Individual scientific-research task_____
(title)</td><td colspan="2">Semester</td></tr>
<tr><td rowspan="2">Total hours – 64[1)]/165</td><td colspan="2">2-nd</td></tr>
<tr><td colspan="2">Lectures [2)]</td></tr>
<tr><td rowspan="6">Weekly rate for daily form of studying (hours):
auditoria – 4,0
self-studying – 10.1</td><td colspan="2">32 hrs</td></tr>
<tr><td colspan="2">Practical, seminar classes [2)]</td></tr>
<tr><td colspan="2">16 hrs</td></tr>
<tr><td colspan="2">Laboratory classes</td></tr>
<tr><td colspan="2">16 hrs</td></tr>
<tr><td colspan="2">Self-studying</td></tr>
<tr><td colspan="2">165 hrs</td></tr>
<tr><td colspan="2">Control type:</td></tr>
<tr><td colspan="2">exam</td></tr>
</table>

[1)] Ratio between auditoria classes to self-studying and individual studying (hours): for daily form of studying – 64/165.

[2)] The classroom load may be reduced or increased by one hour depending on the class schedule.

2. Objective and tasks of the subject

Objective of the course is to study system of structural materials that used for aeronautical engineering and obtain ability of proper selection of structural materials and methods of their treatment.

Tasks

To study main functional properties of metal and non-metal structural materials, methods of their determination and estimation; main physical methods and dependencies that permit to give necessary operational properties to a structural material by means of influence on a material structure, composition, degree of reinforcing and relationships between structural elements.

To get special experience concerning structural materials selection based on their operational properties, external loads, technology of treatment, methods of properties improving, cost of manufacturing and materials availability.

As result of studying students have to:

know:

– requirements to physical-chemical, operational and special properties of structural materials;

– physical phenomenon appearing in metals and allows: processes of crystallization, plastic deformation, thermal and chemical treatment at different environmental conditions;

– classification of structural materials that have proper level of properties and satisfy requirements of availability, supplying terms and make choice of required structural materials;

– methods of properties improving of materials and their definite combinations.

have ability:

– to formulate technical task for developing new materials and methods of improving properties of existing materials;

– to predict level of material properties under operations conditions and at interaction with other materials;

– to select methods of material properties improving up to required level;

– to select methods of materials and articles protection under influence of operational environment;

– to predict possible ways of articles repair and properties renovation;

– to select proper manufacturing process of articles manufacturing and their properties improving.

– to select necessary methods of material properties control.

3. Graduating program

Module 1 – Metals and alloys

Substantial module 1. Physical-mechanical properties of metal structural materials, main groups of metal structural materials

Topic 1. Introduction to the course “Aviation Materials Science”.

Topic 2. Methods of determination of main mechanical properties of metals and alloys.

Topic 3. Metal and alloys structure, methods of influence on metals and alloys structure and properties. Steels.

Substantial module 2. Metal structural materials with special properties

Topic 4. Non-ferrous structural materials (aluminum, titanium, copper and other alloys).

Topic 5. Metals and alloys with special properties.

Topic 6. Special methods of metals structure research

Module 2 – Non-metal structural materials and composites

Substantial module 3. Non-metal structural materials and composites.

Topic 7. Thermosetting and thermoplastic structural materials. Rubbers.

Topic 8. Non-organic structural materials (ceramics, glass, sitalls).

Topic 9. Composite materials. Determination properties of unidirectional composites.

Substantial module 4. Auxiliary non-metal materials.

Topic 10. Application of adhesives for aircraft articles joining.

Topic 11. Paint and varnish protective coatings.

Topic 12. Sealants.

4. The subject arrangement

Substantial modules and topics	Hours				
	Total	including			
		L	P	Lab.	S-s.
1	2	3	4	5	6
Module 1					
Substantial module 1. Physical-mechanical properties of metal structural materials, main groups of metal structural materials					
Topic 1. Introduction to the course "Aviation materials science"	**7**	2	-	-	5
Topic 2. Methods of determination of main mechanical properties of metals and alloys	**20**	2	2	2	14
Topic 3. Metal and alloys structure, methods of influence on metals and alloys structure and properties. Steels.	**24**	4	2	2	16
Total in substantial module 1	**51**	**8**	**4**	**4**	**35**
Substantial module 2. Metal structural materials with special properties					
Topic 4. Non-ferrous structural materials (aluminum, titanium, copper and other alloys)	**28**	4	-	4	20
Topic 5. Metals and alloys with special properties	**12**	2	-	-	10
Topic 6. Special methods of metals structure research	**14**	2	2	-	10
Modular control	**2**	-	-	-	-
Total in substantial module 2	**56**	**8**	**2**	**4**	**40**
Module 2					
Substantial module 3. Non-metal structural materials and composites					
Topic 7. Thermosetting and thermoplastic structural materials. Rubbers	**21**	2	2	2	15
Topic 8. Non-organic structural materials (ceramics, glass, sitalls)	**17**	2	-	-	15
Topic 9. Composite materials. Determination properties of unidirectional composites	**25**	6	2	2	15
Total in substantial module 3	**63**	**10**	**4**	**4**	**45**
Substantial module 4. Auxiliary non-metal materials					
Topic 11. Application of adhesives for aircraft articles joining	**21**	2	2	2	15
Topic 12. Paint and varnish protective coatings	**19**	2	-	2	15
Topic 13. Sealants	**17**	2	-	-	15
Modular control	**2**	-	-	-	-
Total in substantial module 4	**59**	**6**	**2**	**4**	**45**
Total hours	**64**	**32**	**12**	**16**	**165**

5. Topics of seminars

#.	Topics	Hours
1		
	Total hours	

6. Topics of practical lessons

#.	Topics	Hours
1	Micro- and macrostructural analysis of metals and alloys	2
2	Methods of determination of main mechanical properties of metals and alloys	2
3	Phase diagram iron-cementite	2
4	Elastomers (Rubbers)	2
5	Reinforcing materials for composites	2
6	Technology of adhesive joints manufacturing	2
7	Modular control 1	2
8	Modular control 2	2
	Total hours	**16**

7. Topics of laboratory lessons

#.	Topics	Hours
1	Plastic deformations of metals	2
2	Thermal treatment of carbon steels	2
3	Thermal treatment of aluminum alloys	2
4	Thermal treatment of titanium alloys	2
5	Technology of foamed materials manufacturing	2
6	Determination properties of polymeric binders	2
7	Determination mechanical properties of adhesive joints	2
8	Paint and varnish protective coatings	2
	Total hours	**16**

8. Self-studying topics

#.	Topics	Hours
1	Topic 1. Introduction to the course “Aviation materials”	5
2	Topic 2. Methods of determination of main mechanical properties of metals and alloys	14
3	Topic 3. Metal and alloys structure, methods of influence on metals and alloys structure and properties	16
4	Topic 4. Non-ferrous structural materials (aluminum, titanium, copper and other alloys)	20
5	Topic 5. Metals and alloys with special properties	10

6	Topic 6. Special methods of metals structure research	10
7	Topic 7. Thermosetting and thermoplastic structural materials. Rubbers	15
8	Topic 8. Non-organic structural materials (ceramics, glass, sitalls)	15
9	Topic 9. Composite materials	15
10	Topic 10. Determination properties of unidirectional composites	15
11	Topic 11. Application of adhesives for aircraft articles joining	15
12	Topic 12. Paint and varnish protective coatings	15
13	Topic 13. Sealants	15
	Total hours	165

9. Individual tasks

10. Methods of studying

Conduction of auditoria lectures, labs, individual consultation (if necessary), students self-studying by materials published by department (workbooks and textbooks), conduction of olimpiads.

11. Methods of control

Labs passing through multiple-choice testing, written module controls final written exams (if required).

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

12.1. Distribution of student points (quantitative assessment criteria)

Components of educational work	Points per lesson (task)	Number of sessions (tasks)	Total points
Module 1.			
Conduction and defending the laboratory (practical) works	3...5	6	18...30
Modular control	10…20	1	10…20
Module 2.			
Conduction and defending the laboratory (practical) works	3...5	6	18...30
Modular control	10…20	1	10…20
Total for the semester			**60…100**

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 exam / credit. During the semester exam the student can get a maximum of 100 points.

The exam / credit card consists of 30 test questions (100 points total).

12.2. The qualitative evaluation criteria:

The amount of knowledge required to obtain a positive assessment.

As a result of studying the discipline, the student should know:

- Classification and marking of basic structural materials.
- Requirements for physical, chemical, mechanical, operational and special properties of materials and methods of their evaluation.
- Physical phenomena in structural materials, which occur during the formation of the composition and structure of materials, thermal or chemical, heat treatment, during the work of structural materials in different operating conditions.
- Means of improving the properties of structural materials.

The amount of skills required to receive a positive evaluation.

As a result of studying the discipline, the student should be able to:

- To formulate requirements on physical, chemical, operational and special properties of materials.
- Determine the class and subclass of materials that meet the requirements for properties, availability and delivery status, and select the material required.
- Assign a means of improving the properties of materials.

12.3 The criteria for assessing student work during the semester

Satisfactory (60-74). Have a minimum of knowledge and skills. Perform and protect all laboratory work. Be able to determine independently the class and subclass of materials that meet the requirements for properties, availability and delivery status; to prescribe means for improving the properties of materials.

Good (75-89). Know the lecture materials and materials from the self-study section. Navigate in textbooks, guides and guides. Demonstrate the ability to perform and defend all laboratory work within the time limit set by the teacher. Be able to formulate requirements on the properties of materials independently; determine the class and subclass of materials that meet the requirements for properties, availability and delivery status, select the material required; to prescribe means for improving the properties of materials.

Excellent (90 - 100). Know the lecture materials and materials from the section of self-study in full. Know thoroughly all topics and be able to apply them. Navigate in textbooks, guides and guides. It is a mistake to perform and protect all laboratory work within the terms stipulated by the teacher. Be able to formulate requirements on the properties of materials independently; determine the class and subclass of materials that meet the requirements for properties, availability and delivery status, select the material required; to make the forecast of change of properties of materials in the operating conditions; designate materials enhancements, materials and materials to protect parts from harmful effects, materials and materials quality control procedures.

Grading Scale: Points and Traditional

Total points	Score on the traditional scale	
	Exam, differentiated credit	Credit
90 – 100	Excellent	Passed
75 – 89	Good	
60 – 74	Satisfactory	
0 – 59	Unsatisfactory	Not passed

13. Methodological literature sources

Lectures workbooks and textbooks:

1. Ya. Karpov, V. Demenko, P. Lepikhin, O. Popova, V. Sikulskiy, A. Taran, I. Taranenko, T. Yastremska. Physical principles of structural materials selection. –Textbook. –Kharkiv: National aerospace university "Kharkiv aviation institute", 2004 – 403 p.
2. Ya. Karpov, V. Demenko, P. Lepikhin, O. Popova, R. Shevtchuk, V. Sikulskiy, I. Taranenko, T. Yastremska. Structural materials. –Handbook. –Kharkiv: National aerospace university "Kharkiv aviation institute", 2005 – 246 p.
3. Kenneth G. Budinski, Michael K. Budinski, Engineering materials: properties and selection, 9th edition, Prentice-Hall, 2017, - 719 p.
4. ENGINEERING MATERIALS PROPERTIES AND APPLICATIONS OF METALS AND ALLOYS, C. P. SHARMA, Jan 1, 2003, Technology & Engineering, 272 pages.
5. Ahmad K. Elshennawy, Gamal S. Weheba, Manufacturing Processes & Materials, 5th Edition, Society of Manufacturing Engineers (SME), 2015. - 784.
6. Selection of Engineering Materials and Adhesives , Lawrence W. Fisher, P.E., Apr 12, 2005, Technology & Engineering, 608 pages.

Laboratory workbooks:

1. Material engineering and aviation structural materials. Part 1. Metals and alloys / A.A. Vambol, I.M. Taranenko: workbook. – Kharkiv: Nat. Aerospace University «KhAI», 2011. – 78 p.
2. Material engineering and aviation structural materials. Part 2. Non-metals and composites / A.A. Vambol, I.M. Taranenko: workbook. – Kharkiv: Nat. Aerospace University «KhAI», 2011. – 70 p.

14. Recommended literature
Main sources

1. Gulyaev A.P. Physical metallurgy. M., Mir Publisher, 1980, Vol. 1, 2.
2. D.R Askelend. The Science and Engineering of Material, 1989.
3. Serope Kalpakjian. Manufacturing Engineering and Technology, Illinois Institute of Technology: Addison-Wesley Publishing Company, 1990, 1224 pp.
4. William D. Callister, Jr., Fundamentals of Materials Science and Engineering, John Wiley & Sons, Inc., 2001
5. Лахтин Ю.М., Леонтьева В.П. Материаловедение, М. Машиностроение, 1990, 528с.
6. Борисевич В.К., Виноградский А.Ф., Семишов Н.И. Конструкционное материаловедение. Харьков, ХАИ, 1998, 404с.

7. Виноградский А.Ф., Сазоненко Н.Д., Корицкая В.Н. Неметаллические и композиционные материалы, учебное пособие по лабораторному практикуму. Харьков, ХАИ, 1986, 65с.

Auxiliary literature

1. Handbook of Materials Selection for Engineering Applications , George Murray, Jul 3, 1997, Technology & Engineering, 632 pages.
2. Bunsell. A. Fibre reinforcement for composite materials, 1988.
3. Handbook of structural ceramic. Ed. by M.M. Schwartz., 1992.
4. Roman Pampuch. Ceramic materials. An introduction to their properties, 1976.
5. Raymond Chang. Chemistry, 1991.
6. Бабин А.А. English for mechanical engineering students, 1965.
7. Савинский А.Г. English for metallurgical institutes, 1966.

15. Information resources

1. Department site: www.k403.khai.edu; faculty4.khai.edu.