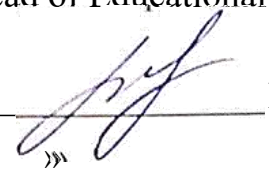
Ministry of Education and Science of Ukraine
National Aerospace University "Kharkiv Aviation Institute"

Department of composite structures and aviation materials (№ 403)

APPROVED
Head of Educational program



_____M. Shevtsova
«___»_____2020

GRADUATING PROGRAM OF THE DISCIPLINE

Mechanics of Reinforced Materials
(title of discipline)

Field of Study: 13 «Mechanical Engineering»
(code and title of the field of study)

Program Subject Area: 134 «Aerospace Engineering»
(code and title of the program subject area)

Educational Program: Design and Manufacturing of Composite Structures
(title of educational program)

Mode of study: Full-time

Degree: Bachelor

Kharkiv 2020

Graduating program of the discipline «**Mechanics of Reinforced Materials**» for students by program subject area **134 «Aerospace Engineering»**, educational program **«Design and Manufacturing of Composite Structures»**.

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Prepared by:
Assoc. prof. of Department of composite structures and aviation materials _____ F. Gagauz
(signature)

Graduating program was approved on Department of composite structures and aviation materials (№403), protocol № 1, 31.08.2020.

Head of Department of composite structures and aviation materials _____ M. Shevtsova
(signature)

1. Description of educational discipline

<table>
<tr><td rowspan="2">Indicators</td><td rowspan="2">Field of Study,
Program Subject Area,
Educational Program,
Degree</td><td colspan="2">Characteristics
of the discipline</td></tr>
<tr><td colspan="2">Daily form of studying</td></tr>
<tr><td>ECTS – 4</td><td rowspan="15">Field of Study
13 Mechanical Engineering
(code and title)

Program Subject Area
134 Aerospace Engineering
(code and title)

Educational Program
«Design and Manufacturing of Composite Structures»

Degree
Bachelor</td><td colspan="2">Cycle of professional training (variative)</td></tr>
<tr><td>Modules – 2</td><td colspan="2">Years of studying</td></tr>
<tr><td>Substantial modules – 2</td><td colspan="2">2020 / 2021</td></tr>
<tr><td rowspan="3">Individual S&R task
_____
_____
(title)</td><td colspan="2">Semester</td></tr>
<tr><td>5-th</td><td>6-th</td></tr>
<tr><td colspan="2">Lectures</td></tr>
<tr><td rowspan="2">Total hours – 120</td><td>32 hrs</td><td>-</td></tr>
<tr><td colspan="2">Practical, seminar classes</td></tr>
<tr><td rowspan="3">Weekly rate for daily form of studying:
- auditoria – 3.5
- self-studying – 4</td><td>24 hrs</td><td>-</td></tr>
<tr><td colspan="2">Laboratory classes</td></tr>
<tr><td>-</td><td>-</td></tr>
<tr><td colspan="2">Self-studying</td></tr>
<tr><td>64 hrs</td><td>-</td></tr>
<tr><td colspan="2">Individual studying</td></tr>
<tr><td>–</td><td>–</td></tr>
<tr><td colspan="2">Control</td></tr>
<tr><td>exam</td><td>-</td></tr>
</table>

Notes:
Ratio between auditoria classes to self-studying and individual studying (hours): 56/64.

2. Objective and aims of the discipline

Objectives: formation of students' professional profile knowledge and practical skills for analytical research of reinforced materials (forecasting of effective elastic properties, analysis of stress-strain state, etc.).

Aims: study of the basics of micromechanics of reinforced materials and mechanics of laminate needed to determine the physical and mechanical characteristics of composite materials (composites). The course is the basis for further study of disciplines related to strength calculation, design and construction, as well as the production of products with composites.

As result of studying students have to:

know:

- Basic relations of the mechanics of a deformable solid;
- The most common models of composites, which are used to determine their physical and mechanical properties;
- Basic theories and criteria of strength of orthotropic materials used in the calculation of composites for strength;
- Methods of properties calculation and stress-strain state of layered composites;
- The degree of influence of the structure and scheme of reinforcement on the effectiveness of the application of composites;
- Methods of experimental study of the properties of layered composites.

be able:

- Determine the deformation properties and strength characteristics of unidirectional and layered composites under simple loading;
- Evaluate the strength of layered composites under complex mechanical and thermomechanical loading;
- Use computer software in engineering practice to program the calculation of layered composites.

3. Content of the discipline

Module 1.
Substantial module 1. Mechanics of unidirectional lamina.
Topic 1. Generalized physical law of solid body**.**
Topic 2. Micromechanics of a lamina**.**
Topic 3. Micromechanics of off-axis lamina**.**
Module control №1.

Module 2.
Substantial module 2. Mechanics of laminates.
Topic 4. Classical theory of laminates**.**
Topic 5. Determination of elastic and thermomechanical characteristics of laminates**.**
Topic 6. Determination of strength characteristics of laminates**.**
Topic 7. Strength analysis of laminates under complex loading**.**
Module control №2.

4. Arrangement of the discipline

Substantial modules and topics	Hours					
	Total	including				
		Lec-tures	Prac-tical works	Labs.	Ind. work	Self-stud-ying
1	**2**	**3**	**4**	**5**	**6**	**7**
Module 1.						
Substantial module 1. Mechanics of unidirectional lamina						
Topic 1. Generalized physical law of solid body	14	2	2	-	–	10
Topic 2. Micromechanics of a lamina	20	6	2	–	–	12
Topic 3. Micromechanics of off-axis lamina	16	4	2	-	–	8
Total in substantial module 1	**48**	**12**	**6**	-	–	**30**
Module 2.						
Substantial module 2. Mechanics of laminates						
Topic 4. Classical theory of laminates	12	4	–	–	–	8
Topic 5. Determination of elastic and thermo-mechanical characteristics of laminates	20	6	6	–	–	8
Topic 6. Determination of strength characteris-tics of laminates	24	6	8	–	–	10
Topic 7. Strength analysis of laminates under complex loading	16	4	4	–	–	8
Total in substantial module 2	**72**	**20**	**18**	–	–	**34**
Total hours	**120**	**32**	**24**	-	–	**64**

5. Topics of practical classes

№	Topics	Hours
1	Hooke's law for orthotropic and anisotropic bodies	2
2	Prediction of elastic, thermoelastic and strength properties of unidirectional composites by the properties of components and their volumetric content	2
3	Rotational transformations of stresses, strains and elastic constants of unidirectional lamina	2
4	Effective elastic constants of laminate with arbitrary lay-up	2
5	Effective thermo-elastic constants of laminate with arbitrary lay-up	2
6	Influence of laminate stacking sequence parameters on elastic properties of composites	2
7	Influence of laminate stacking sequence parameters on thermo-elastic constants of composites	2
8	Stress-strain analysis of laminate under in-plane loading	2
9	Determination of strength properties of unidirectional composite in simple load cases	2
10	Prediction of strength properties of laminates	2
11	Influence of laminate structural parameters on strength properties	2
12	Layer-by-layer approach to strength analysis of laminates under complex loading	2
	Total	**24**

6. Self-studying topics

№	Topics	Hours
1	Generalized physical law of solid body	10
2	Micromechanics of a lamina	12
3	Micromechanics of off-axis lamina	8
4	Classical theory of laminates	8
5	Determination of elastic and thermomechanical characteristics of laminates	8
6	Determination of strength characteristics of laminates	10
7	Strength analysis of laminates under complex loading	8
	Total	**64**

7. Methods of studying

Conduction of auditoria lectures, practical classes, individual consultation (if necessary), students self-studying by materials published by department (workbooks and textbooks), performing of settlement work.

8. Methods of control

Current control in the form grading the practical works, module controls in the form of testing, grading of settlement work, final exam (if required).

9. Score points distribution

Components of educational work	Scores for one entity		Number of classes	Total scores	
	min	max		min	max
Substantial module 1					
Practical classes	3	5	3	9	15
Module control №1	6	10	1	6	10
Total in substantial module				15	25
Substantial module 2					
Practical classes	3	5	9	27	45
Settlement work	12	20	1	12	20
Module control №2	6	10	1	6	10
Total in substantial module				45	75
Total in semester				**60**	**100**
* Mandatory control work					

Estimation scale: national and ECTS

Total score by all studying activities	**ECTS scale**	**Mark by national scale**
90 – 100	A	excellent
83 – 89	B	good
75 – 82	C	
68 – 74	D	satisfactory
60 – 67	E	
1 – 59	FX	not passed (repassing is allowed)

10. Methodological support

Methodical instructions for performing practical work, as well as for settlement work.

11. Recommended literature

1. Valery V. Vasiliev, Evgeny E. Morosov. Mechanics and analysis of composite materials. 2001, 418 p.
2. Barbero E. Introduction to Composite Materials Design. 3rd Edition. – CRC Press, 2018. – 573 p.
3. Mechanics of composite materials. Robert M. Jones. – 2nd ed. – CRC Press, 1999. – 538 p.

12. Information resources

Department web-site **http://k403.khai.edu**