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

Department of Aircraft Manufacturing Technology (# 104)

APPROVED
Guarantor of the educational program
Head of the EMC
_____ Sergiy Nyzhnik
(signature) (initials and surname)
« 30 » 08 2024

THE WORK PROGRAM OF MANDATORY EDUCATIONAL DISCIPLINE

Welding in Aircraft Manufacturing

(name of the discipline)

Field of knowledge: 13 "Mechanical Engineering"
14 «Electrical Engineering»
27 «Transport services»

(code and name of the field of knowledge)

Specialty: 131 Applied mechanics
133 Industrial machinery engineering
134 Aviation and aerospace technologies
141 Electrical energetics, electrical engineering and electromechanics
142 Power machinery
144 Thermal power engineering
272 Aviation transport
274 Motor vehicle transport

(code and name of the specialty)

Educational program: in all educational programs of specialties
(name of educational program)

Form of study: full-time

Level of higher education: first (bachelor's)

Kharkiv 2024

Developer: Nikichanov V.V. Candidate of Engineering Sciences, Associate professor at the Dep. #104 

The work program was considered at the meeting of the Department of Aircraft Manufacturing Technology (#104)

Protocol № 1 from "30" August 2024

Head of the Department: PhD, Docent  Katerina Maiorova

(Sci. Degree and Acad. Title) (Signature) (name and surname)

1. Description of the discipline

<table>
<tr><td>Characteristic</td><td>Field of knowledge, specialty, educational program, level of higher education</td><td>Characteristics of the discipline
(full-time education)</td></tr>
<tr><td>Number of credits 5.0</td><td rowspan="14">Branch of knowledge
13 "Mechanical Engineering"
14 «Electrical Engineering»
27 «Transport services»
code and name)

Program Subject Area
131 Applied mechanics
133 Industrial machinery engineering
134 Aviation and aerospace technologies
141 Electrical energetics, electrical engineering and electromechanics
142 Power machinery
144 Thermal power engineering
272 Aviation transport
274 Motor vehicle transport
(Code and Name)

Educational program
in all educational programs of specialties
(name)

Level of higher education:

first (bachelor's)</td><td>The cycle of general (professional) training is mandatory</td></tr>
<tr><td>Number of modules 1</td><td>Academic year</td></tr>
<tr><td>Number of content modules 2</td><td>2022/2023</td></tr>
<tr><td rowspan="2">Individual task
not necessary</td><td>Semester</td></tr>
<tr><td>4t/6th</td></tr>
<tr><td rowspan="2">The total number of hours is 64/150</td><td>Lectures *</td></tr>
<tr><td>32 hours</td></tr>
<tr><td rowspan="8">Weekly hours for full-time study:
classroom - 4
independent student work – 5.375</td><td>Practical, seminar *</td></tr>
<tr><td>32 hours</td></tr>
<tr><td>Laboratory *</td></tr>
<tr><td>-</td></tr>
<tr><td>Individual work</td></tr>
<tr><td>86 hours</td></tr>
<tr><td>type of control</td></tr>
<tr><td>modular control, exam</td></tr>
</table>

The ratio of the number of hours of classroom classes to independent work is:

64/86

Classroom hours may be reduced or increased by one hour depending on the class schedule.

2. The purpose and objectives of the discipline

The purpose: providing students with knowledge and skills in the basics of welding, which are necessary for the engineer in the manufacture and repair of aircraft parts, using different types of welding.

TheTask: study of modern methods of production of parts, assemblies and units of aircraft and engines with the use of welding.

After mastering the discipline, the applicant will acquire the following **competencies (prerequisites):**

GC 3. The skills of safe activities, the desire to preserve the environment.

GC 5. Ability to work in a team.

GC 6. Ability to generate new ideas (creativity).

GC 8. Ability to learn and master modern knowledge

PC 6. The ability to develop and implement technological processes for the production of elements and objects of aviation equipment

It is expected that after mastering the discipline, the applicant will achieve the following learning **outcomes** (**co-requisites**) and he will**:**

PLO 2. Understand ecologically dangerous and harmful factors of professional activity and adjust its content in order to prevent negative impact on the environment.

PLO 4. Explain your decisions and the grounds for their acceptance to specialists and non-specialists in a clear and unambiguous way.

PLO 8. To comply with the requirements of industry regulations regarding the design, production, testing and (or) certification procedures of elements and objects of aviation equipment at all stages of their life cycle.

Interdisciplinary connections:

	The list of disciplines that are required to study the discipline "Welding in aircraft manufacturing"
1	Physics
2	Chemistry and basics of ecology
3	Electrical engineering
4	Materials science, Technologies of engineering materials
5	Engineering and computer graphics
6	Mechanics of materials and conctructions

Disciplines, the study of which is based on the discipline "Welding in aviation"

1	Technology of Aircraft and helicopter production
2	System of automated design of production preparation technology
3	Designing of aircraft manufacturing enterprises

3. The content of the discipline
Module 1.

Content module 1. Fusion welding.

Topic 1. Theoretical foundations of welding. The use of welding processes in aircraft construction. Advantages and disadvantages. The physical essence of the formation of a welded joint during fusion and pressure welding. Classification of welding methods by physical characteristics. The concept of heat flow, its power. Calculated schemes of heat sources. Laws of thermal conductivity of convective and radiant heat transfer. Equation of total thermal conductivity. Schemes of thermal fields under the influence of point moving and stationary heat sources in a semi-infinite body. Metallurgical processes during welding. Ways to improve the quality of welded joints. Weld crystallization. The structure of the seam and the heat affected zone. Types and kinds of welded joints, their classification and designation

Topic 2. Fusion welding methods. Arc welding. Welding arc and physical processes occurring in it. The structure of the welding arc, its characteristics. Volt-ampere characteristic of the arc. Welding arc power sources. Power supply requirements. Classification of power sources. Classification of arc welding methods by technical and technological features. External characteristics of power sources, their types and purpose. Methods of regulation and control of welding current. Manual arc welding with noneconsumable and consumable electrodes. Scheme and essence of the process. Features of electrodes and power sources of the welding arc. Process parameters. Advantages and disadvantages. Submerged arc welding. Scheme and essence of the process. Features of the process and equipment. Process parameters. Advantages and disadvantages. Tungsten inert gas welding. Scheme and essence of the welding process, features. Process parameters. Equipment. Advantages and disadvantages. Metal inert gas/ gas metal arc welding. Scheme and essence of the welding process, features. Process parameters. Equipment. Advantages and disadvantages. Plasma welding. Scheme and essence of the welding process. Process parameters. Equipment. Advantages and disadvantages. Electron beam welding. Scheme and essence of the welding process. Process parameters. Advantages and disadvantages. Laser welding. Scheme and essence of the welding process. Welding process parameters. Equipment. Advantages and disadvantages. Electrogas welding. Scheme and parameters of the process. Types of equipment. Advantages and disadvantages. Field of application. Electroslag welding. Scheme and parameters of the process. Types of equipment. Advantages and disadvantages. Field of application Oxyfuel

gas welding. Flammable gases. Properties of acetylene and oxygen. The process of fuel gas burning. Process parameters. Advantages and disadvantages. Field of application. Thermite welding. Advantages and disadvantages. Field of application

Modular control

Content module 2. Pressure welding and Allied processes.

Topic 1. Heat and pressure welding methods. Resistance spot welding. The scheme and essence of the process. Welded joint formation. Spot weld and process parameters. Basic machine systems for spot welding and their purpose. Advantages and disadvantages. Resistance seam welding. The essence of the process. Basic parameters. Equipment. Advantages and disadvantages. Resistance butt welding& resistance flash welding. The essence, features of the welding method. Welding process parameters. Advantages and disadvantages.. Machines for resistance welding. Diffusion welding. Schemes and essence of the process. The main parameters of welding. Application ranges. Advantages and disadvantages

Topic 2. Pressure and friction welding methods. Cold pressure welding. The scheme and essence of the process of weld formation. types of welding method. Process parameters. Basic systems of machines for cold pressure welding and their purpose. Advantages and disadvantages. Friction welding. The scheme and essence of the process of connection formation. Varieties of welding method. Process parameters. Features of education and its composition. Advantages and disadvantages. Ultrasonic welding. Scheme and essence of the process of joint formation Varieties of ultrasonic welding. Welding process parameters. Advantages and disadvantages. Application area. Explosive welding. The scheme and essence of the process of connection formation. Process parameters. Features of the welded joint. The scheme of obtaining multilayer materials. Advantages and disadvantages.

Topic 3. Allied processes. Brazing &Soldering of metals. The physical essence of the process of formation of a brazed or soldered joint. Types of braziers and solders. Soldering /brazing methods their peculiarities. feature, advantages and disadvantages. Application of Soldering and brazing. Surfacing, types and peculiarities of the processes.

Modular control

4. The structure of the discipline

The name of the content module and topics	Number of hours				
	Total	Including			
		Lect.	Pract.	Lab.	Ind. work
1	2	3	4	5	6
Module 1					
Content module 1. Fusion welding methods.					
Topic 1. Theoretical foundations of welding.	20	4			16
Topic 2. Fusion welding methods.	45	12		15	18
Modular control	1			1	
Total hours on a Content Module 1	66	16		16	34
Content module 2. Pressure welding and Allied processes.					
Topic 1. Heat and pressure welding methods.	36	6		12	18
Topic 2. Pressure and friction welding methods	26	6		3	17
Topic 3. Allied processes. Brazing &Soldering of metals. Surfacing, types and peculiarities of the processes	21	4			17
Modular control	1			1	
Total hours on a Content Module 2	84	16		16	36
Total hours	**150**	**32**		**32**	**86**

5. Topics of seminars

№ p / p	Name of topics	Number of hours
1		
	Total	

6. Topics of practical classes

№ p / p	Name of topics	Number of hours
1		
	Total	

7. Topics of laboratory classes

№ p / p	Name oftopics	Number of hours
1	Manual arc welding on AC devices	4
2	Analysis of electric arc attributes and equipment for tig welding	4
3	Machine submerged welding	4
4	Microplasma welding	4
5	Resistance spot welding	4
6	Resistance butt welding and brazing	4
7	Resistance seam welding	4
8	Cold pressure welding for plastic metals	4
	Total	**32**

8. Independent work

№ p / p	Name topics	Number of hours
1	Topic 1. Theoretical foundations of welding.	16
2	Topic 2. Fusion welding methods.	18
3	Topic 3. Heat and pressure welding methods	18
4	Topic 4. Pressure and friction welding methods.	17
5	Topic 5. Allied processes. Brazing &Soldering of metals. Surfacing, types and peculiarities of the processes	17
	Total	**86**

9. Individual tasks

Not provided

10. Teaching methods

Lectures are informational and verbal with the use of electronic didactic demonstration materials (presentations). Methods such as conversation and heuristic conversation are used in lectures, during which a clear system is used, pre-defined questions that contribute to the active assimilation by students of the system of facts, new concepts and patterns.

Preparation for the lecture involves the study of the material of the previous lecture on the syllabus, textbook.

Laboratory classes begin with an explanation using electronic didactic demonstration materials (presentations). Then training exercises are performed according to a certain pattern. A mandatory element of the laboratory lesson is to compile a report.

Preparation for laboratory classes involves the processing of lecture material and material in the laboratory workshop in.

Processing of program sections, which are not considered during lectures, provides students with a synopsis of relevant thematic issues. For this purpose textbooks, network Internet resources are used.

Preparation for modular control involves the study of theoretical issues, the list of which is posted for self-control.

11. Assessment Methods

During the study of the discipline, the following types of assessment are provided: current during practical classes; modular during the semester; final assessment in the form of a written exam.

12. Evaluation criteria and distribution of points received by students

12.1. Distribution of points received by students (quantitative evaluation criteria)

Components of educational work	Points for one lesson	Number of classes	Total number of points
Content module 1			
Activity on lectures	0…1,25	8	0…10
Performance and defence of laboratory works	0…5	3	0…15
Modular control	15… 25	1	15… 25
Content module 2			
Activity on lectures	0…1,25	8	0…10
Performance and defence of laboratory works	0…5	3	0…15
Modular control	15… 25	1	15… 25
Total for the semester			**60… 100**

The semester control (exam) is carried out in case of refusal of the student from points of current testing and in the presence of the admission to exam / credit. During the semester exam / test the student has the opportunity to receive

The ticket for the exam / test consists of two questions, the maximum number of points for the first question -30 points, the second -30 points, for semester laboratory work -40 points (sum - 100 points).

12.2. Qualitative evaluation criteria

The required amount of knowledge to obtain a positive assessment:

physico-chemical processes that occur during welding;

principles of operation and technological capabilities of modern types of welding;

features of welding of the basic constructional materials by various ways of welding;

possible defects and methods of quality control of welding.

The required amount of skills to obtain a positive assessment:

design welded parts, assemblies and units of aircraft, which are produced using different types of welding;

to develop technological processes of manufacturing the structure with the use of welding and quality control of welding;

to choose the modes of welding of joints, which are obtained using different types of welding, for different structural materials.

12.3 Criteria for evaluating student work during the semester

Satisfactory (60-74). The student knows a significant part of the theoretical material provided by the work program. Work out and defend all laboratory works and individual tasks, shows knowledge and skills of basic principles, but the depth of knowledge is insufficient. And only with the help of the teacher the student can analyse the educational material, correct mistakes, among which there is a significant number of significant errors.

Good (75 - 89). Firmly know the minimum knowledge, perform all tasks. Demonstrate the ability to perform and defend all laboratory work within the period specified by the teacher with a justification of the decisions and measures proposed in the works. To be able to design technological means the student freely owns the studied volume of the educational material provided by the working program and skilfully uses it in practice, independently solves problems in standard situations and corrects the mistakes which quantity is insignificant.

Excellent (90 - 100). Fully knowing the basic and additional material of the academic discipline. Navigate in textbooks and manuals. Unmistakably perform and defend all laboratory work. Be able to determine the technological parameters of different kinds of weldments Firmly and perfectly knows the material of the work program, while showing special creative abilities, is able to independently and without the help of the teacher to find and process the necessary information. Is able to competently use the acquired knowledge and skills to make decisions in unusual situations, convincingly and logically argue decisions.

Grading scale: point and traditional

The sum of points	Score on a traditional scale	
	Exam, differentiated test	Test
90 - 100	Perfectly	Credited
75 - 89	Fine	
60 - 74	Satisfactorily	
0 - 59	Unsatisfactorily	Not credited

13. Methodical support

1. Welding / M. A. Varukha, S. M. Lashko, T. A. Yastremskaya. – Practical workbook. – Kharkiv: National aerospace university „KhAI", 2007. – 52 p.

14. Recommended reading

1. Klas Weman, Liber AB. Welding Processes Handbook (Second edition)/Woodhead Publishing Limited, 2012. 270 p.

2. Larry Jeffus Welding: Principles and Applications (8th edition), Printed in the United States of America, 2015. 1050p.

3. ASM Handbook, Vol. 6A, Welding Fundamentals and Processes, 2011. 1049 p.

4. AWS A3.0M/A3.0:2010 An American National Standard. Standard Welding Terms and Definitions, 2009. 148 p.

5. EN ISO 9692-1:2013 Welding and allied processes - Types of joint preparation - Part 1: Manual metal arc welding, gas-shielded metal arc welding, gas welding, TIG welding and beam welding of steels. 15 p.

6. ISO 15609-1:2018 Specification and qualification of welding procedures for metallic materials – Welding procedure specification – Part 1: Arc welding, Published in Switzerland. 7 p.

15. Information resources

1. https://www.twi-global.com/technical-knowledge/faqs/what-is-welding#howitworks

2. Training course in the distance learning system Mentor: https://mentor.khai.edu/course/view.php?id=2333

3. Training course in the distance learning system Mentor: https://mentor.khai.edu/course/view.php?id=885

4. Electronic library of the department №104: \\ Domik \ SHARED \ Methodical materials.

5. Electronic Library of the National Aerospace University "KhAI": http://library.khai.edu

6. https://mentor.khai.edu/mod/folder/view.php?id=17660