

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

Department of Aircraft Manufacturing (#104)

APPROVED

Guarantor of the
Educational Program



(Signature)

M. ORLOVSKIY

(Name and Surname)

« ____ » _____ year 2022

**WORK PROGRAM
OF OPTIONAL EDUCATIONAL DISCIPLINE**

**" FUNDAMENTALS OF AIRCRAFTS MANUFACTURING AND
MAINTENANCE "**

(Name Of Academic Discipline)

Field of Knowledge: 27 "Transport"
(Code And Name Of The Field Of Knowledge)

Program Subject Area: 272 " Aviation Transport "
(Code And Name Of The Specialty)

Educational Program: " Maintenance and Repair of Aircraft and Aircraft
Engines "
(Name Of Educational Program)

Training Mode: Full-Time

Level of Higher Education: First (Bachelor)

Kharkiv 2022

Developer: Shypul O. V., Associate Professor, PhD of Technical Sciences, Associate Professor at the Dep. #104

(surname and initials, position, academic degree, and academic title)



(Signature)

Pavlenko O. A., PhD of Technical Sciences, Associate Professor at the Dep. #104

(surname and initials, position, academic degree, and academic title)



(Signature)

Myronova S., Yu., Senior Lecturer at the Dep. #104

(surname and initials, position, academic degree, and academic title)



(Signature)

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

(The Department Name)

Protocol № 1 from "31" August 2022

Head of the Department: Associate Professor, PhD of Technical Sciences

(Sci. Degree And Acad. Title)

(Signature)

Kateryna MAJOROVA



(Name And Surname)

1. Description of the discipline

Characteristic	Field of knowledge, specialty, educational program, level of higher education	Characteristics of the discipline (full-time education)
ECTS – 7.0	<p>Branch of knowledge <u>27 Transport</u> (code and name)</p> <p>Program Subject Area <u>272 Aviation Transport</u></p> <p>Educational program <u>Maintenance and Repair of Aircraft and Aircraft Engines</u></p> <p>Level of higher education: <u>first (bachelor)</u></p>	Optional
Number of modules - 2		Academic year
Number of content modules - 4		2021/2022
Individual task – <u>Calculation And Graphic Work, Term Project</u>		Semester
		6th 7th
The total hours is 80*/210		Lectures *
		32 hours 0 hours
Weekly hours for full-time study: classroom - 2.35 independent work of the student – 3.82		Practical, Seminar *
		0 hours 0 hours
		Laboratory *
		32 hours 16 hours
		Individual Work
		86 hours 44 hours
		Type of Control
Exam Dif. test		

The ratio of the number of hours of classroom classes to independent work is: 80 / 130.

*Classroom load can be reduced or increased by one hour depending on the class schedule.

2. The purpose and objectives of the discipline

The Goal: to form knowledge and skills that allow to scientifically solve modern issues of production and repair of aircraft by studying technological systems of modern production and repair of aircraft, modern technological processes, equipment and means of technological equipment for the manufacture and repair of aircraft.

The Task: study of technological systems as part of production and repair systems of modern aircraft and rocketry, their structures, basic characteristics and indicators; objects of technological transformations and technological requirements to designs of aircraft; modern technological processes, equipment and means of technological equipment for the manufacture and repair of aircraft.

The Acquired Competencies:

GC 1. Ability to communicate in the state language both orally and in writing.

GC 2. Ability to apply knowledge in practical situations.

GC 3. Knowledge and understanding of the subject area and understanding of professional activity.

GC 7. Ability to make informed decisions.

GC 8. Ability to learn and master modern knowledge.

GC 9. Safe activities skills.

GC 10. Ability to evaluate and ensure the quality of work performed.

PC4. Ability to provide safety and labor protection at the work site.

PC7. Skills to work with regulations, reference books and other sources of information governing the activities of air transport.

PC8. Ability to participate in a set of planned and preventive works to ensure the serviceability, efficiency and readiness of aircraft to effectively use them for their intended purpose.

PC10. Ability to use the latest integrated computer technology in the creation (production) of aircraft.

The Expected Learning Outcomes:

PLO 3. Have the means of modern information and communication technologies to the extent sufficient for training and professional activities.

PLO 4. Explain their decisions and the basis for their adoption to specialists and non-specialists in a clear and unambiguous form.

PLO 7. Summarize information on regulatory documentation, reference literature and other sources of information governing the activities of air transport.

PLO 8. Ensure the implementation of a set of planned and preventive work on aircraft in order to maintain it ready for effective use as intended.

PLO 9. Ensure the implementation of professional primary skills, including metalwork, manufacture and repair of simple parts, assembly of components to ensure the serviceability, efficiency and readiness of aircraft for their intended use and with the lowest operating costs.

PLO 10. Analyze the technical documentation and established reporting according to the approved forms, including the accounting of resource and technical condition of aircraft.

PLO 11. To plan the solution of tasks on technical operation of aircraft, operational reliability, regularity of flights, organization, information and hardware of production processes on maintenance and repair of aircraft.

PLO 12. Analyze the reliability of aircraft, the experience of its technical operation and plan measures to prevent aviation events and incidents, failures and damage to aircraft in order to maintain the airworthiness of aircraft.

Prerequisites - Physics; Theoretical Mechanics; Interchangeability and Standardization; Aviation Materials Science.

Co-requisites - Mechanics of Materials and Structures; Technologies of Construction Materials; Theory of Mechanisms and Machines.

3. The Content Of The Discipline

Module 1.

Content module 1. *Technology of production of aircraft parts by dimensional processing.*

Topic 1. Theoretical bases of machining of parts. Basic principles of designing standard operations of machining and repair of aircraft parts

Types of technological processes of machining. Structural and technological features of standard parts machined on metal-cutting machines. The structure of the technological process of machining: operation, technological transition, working and auxiliary moves, institutions, position. Types of blanks and semi-finished products used for machining.

Topic 2. Evaluation of the efficiency of machining. Cutting modes, their definition and selection methods. Accuracy of machining

Operating allowance, its components, the order of its purpose and the method of calculating the size of the workpiece. Basic principles of operation and structural elements of cutting tools. Cutting modes, their definition and methods of selection, the impact on the efficiency of machining. Accuracy of machining, accuracy categories. Methods for assessing the accuracy of machining.

Topic 3. Features, methods and types of mechanical surface treatment of aircraft parts with a blade tool in the repair of aircraft

Features of processing on lathes of various surfaces. Cutting tools, types of lathes and machine tools used for turning. Drilling. Features of the cutting process when drilling different holes. Technological features of processing of openings by countersinking, and development. Processing of parts by drawing. Milling, its types and technological features.

Topic 4. Features, methods and types of abrasive machining of surfaces of parts in the repair of aircraft

Grinding. Features of the grinding process, its types. Tools, equipment and devices used for grinding. Honing and superfinish. Significance of processes, their technological features, the tool used and the edge of application. Final and final methods of free abrasive treatment.

Modular control

Content module 2. *Procurement and stamping production of aircraft parts.*

Topic 1. General characteristics of procurement and stamping production

(Sheet Metal Stamping) and parts of aircraft objects obtained by SSW methods.

Features of the object of aircraft as an object of production. General characteristics of procurement and stamping works. The main operations of Sheet Metal Stamping. Materials and semi-finished products used for the manufacture of parts of aircraft objects in Sheet Metal Stamping.

Topic 2. Production of flat blanks and parts from sheet. Obtaining parts of objects of aircraft of a spatial form from sheet preparations by bending, drawing and tightening.

Classification of processes of cutting of sheet preparations. Cutting cards. Cutting of sheet material on scissors, milling, in stamps. Structural solutions of dies for cutting-punching. Production of parts of aircraft objects by extraction from the sheet - existing schemes, progressive methods. Production of parts of aircraft objects by bending - existing schemes, technological equipment and facilities. Production of aircraft parts by rubber molding. Production of coverings of objects of aircraft.

Topic 3. Features of manufacturing parts of aircraft objects from profiles and pipes.

Distribution operations during the manufacture of parts of aircraft objects from profiles and pipes. Existing ways of bending profiles. Drawing and trimming profiles. Bending of profiles with stretching. Forming operations in the manufacture of parts from pipes - methods and equipment for bending, distribution and crimping of pipes used in the production of aircraft objects.

Topic 4. Special methods of distribution of semi-finished products and formation of parts of aircraft objects in Sheet Metal Stamping.

High-energy methods of stamping parts of aircraft objects - characteristics of parts and materials for which special methods of distribution of semi-finished products and molding are used. Existing shaping schemes. Technological equipment and facilities.

Modular control

Content module 3. *Welding and allied processes*

Topic 1. Theoretical fundamentals of welding and allied processes.

The use of welding and allied processes in the manufacture and repair of aircraft. Advantages and disadvantages of welding. The physical essence of a welded joint formation, types of welding joints. Welding Defects. Classification of welding methods on physical, technical and technological principal. Classification of allied processes according to international systems standards ISO and AWS. Estimated schemes of heat sources and their effective power. Metallurgical processes during fusion welding. Fusion weld crystallization. Microstructure of a weld and a heat affected zone.

Topic 2. Thermal class of welding and allied processes.

Oxyfuel (gas) welding and allied processes. Welding arc, its structure and characteristics. Classification of arc welding methods on technical and technological principles. Using fluxes and gases for increasing the productivity of processes and

improving the weldments quality. Scheme and essence of some welding methods. Flux-cored welding. Arc welding in shield gases with consumable and non-consumable electrodes. Methods of gas protection. Submerged arc welding. Electroslag arc welding. Atomic hydrogen arc welding. Plasma arc welding. Advantages and disadvantages of methods, fields of their application. High energy density kinds of welding and allied processes. Laser welding and allied processes. Electron-beam welding. Advantages and disadvantages. Field of use. Thermite welding process.

Topic 3. Thermo-mechanical class of welding and allied processes.

Types of Resistance welding. Resistance spot welding. Resistance butt welding. The main parameters of the welding process, types of equipment work-cycles. Advantages and disadvantages. Diffusion welding – essence of process, advantages and disadvantages.

Topic 4. Mechanical class of welding and allied processes.

Friction welding. Friction stir welding Cold welding. Scheme and essence of welding method, main parameters of the welding process, advantages and disadvantages. Ultrasonic welding. The scheme and essence of the welding process. The main parameters of the welding process. Explosion welding. Advantages and disadvantages.

Topic 5. Soldering and Brazing processes. Surfacing (Building up) methods. Additive manufacturing.

Physical processes of solder/brazed joint formation. Types of heat source. Advantages and disadvantages. Additive manufacturing processes, their classification according to ISO, fields of application and prospects for the aircraft manufacturing and repair.

Module 2.

Content module 4. *Development of aircraft manufacturing technology and tooling design.*

Topic 1. Development of technology for the manufacture of sheet metal aircraft

Stamping schemes used in the manufacture of aircraft parts by cutting and punching from sheet. Determining the dimensions of the workpiece-strip for stamping. Selection of a sheet of standard sizes based on calculations of the material utilization factor. Methods for determining the power parameters of distribution stamping.

Topic 2. Design of special technological equipment for the manufacture of sheet metal parts of the aircraft

Methods for determining the pressure center of the distribution stamp. Existing designs of dies for distribution of sheet material. Standards for typical stamp elements. Methods of designing working parts of the stamp. Execution of technological documentation on the technological process of manufacturing parts by stamping from sheet.

Modular control

4. The Structure Of The Discipline

The name of the content module and topics	Hours				
	Total	Including			
		Lect.	Pract.	Lab.	Ind. work
1	2	3	4	5	6
Module 1					
Content module 1. Technology of production of aircraft parts by dimensional processing					
Topic 1. Theoretical bases of machining of parts. Basic principles of designing standard operations of machining and repair of aircraft parts.	13	2		4	7
Topic 2. Evaluation of the efficiency of machining. Cutting modes, their definition and selection methods. Accuracy of machining.	13	2		4	7
Topic 3. Features, methods and types of mechanical surface treatment of aircraft parts with a blade tool when repairing aircraft.	11	2		2	7
Topic 4. Features, methods and types of abrasive machining of surfaces of parts in the repair of aircraft	9	2			7
Modular control	2	2			
Total hours on a Content Module 1	48	10		10	28
Content module 2. Procurement and stamping production of aircraft parts.					
Topic 1. General characteristics of Sheet Metal Stamping.	11	2		2	7
Topic 2. Production of flat blanks and parts from sheet in stamps. Progressive methods of material distribution.	15	2		6	7
Topic 3. Manufacture of aircraft parts and helicopters by bending from sheet.	11	2		2	7
Topic 4. Production of aircraft and helicopter parts from profiles and pipes.	11	2		2	7
Modular control	2	2			
Total hours on a Content Module 2	50	10		12	28
Content module 3. Welding and allied processes					
Topic 1. Theoretical fundamentals of welding and allied processes	8	2			6
Topic 2. Thermal class of welding and allied processes.	10	2		2	6
Topic 3. Thermo-mechanical class of welding and allied processes methods.	12	2		4	6
Topic 4. Mechanical class of welding and allied processes	10	2		2	6
Topic 5. Soldering and Brazing	10	2		2	6

processes. Surfacing (Building up) methods. Additive manufacturing.					
Modular control	2	2			
Total hours on a Content Module 3	52	12		10	30
Total hours per semester	150	32		32	86
Module 2					
Content module 4. Development of aircraft manufacturing technology and equipment design					
Topic 1. Development of technology for the manufacture of sheet metal aircraft.	6			6	
Topic 2. Design of special technological equipment for the manufacture of sheet metal parts of the aircraft.	10			10	
Individual task - Term project	44				44
Total hours on a Content Module 4	60			16	44
Total hours per semester	60			16	44
Total hours	210	32		48	130

5. Topics of Seminars

#	Topic Name	Number of hours
1		
	Total	

6. Topics of Practical Classes

#	Topic Name	Number of hours
	Total	

7. Topics of Laboratory Classes

#	Topic Name	Number of hours
1	Workpiece locating and designing of machine accessories	4
2	Study of kinematic elements and geometrical parameters of turning	2
3	Workpiece locating and dressing of machine accessories	2
4	Calculation of cutting mode for parts machining on NC turning tools	2
5	Production of aircraft parts by sheet metal stamping on mechanical presses	2
6	Multi-transition deep drawing of sheet blanks	2
7	Production of aircraft parts by bending	2
8	Production of aircraft parts by covering	2
9	Deformation of pipes	2

10	Stamping in tool dies with elastic medium	2
11	Arc welding in argon with a non-consumable electrode (TIG)	2
12	Resistance spot welding	4
13	Resistance butt welding	2
14	Cold welding	2
15	Development of technology for the manufacture of sheet metal aircraft	6
16	Design of special technological equipment for the manufacture of sheet metal parts of the aircraft	10
	Total hours	48

8. Independent work

#	Topic Name	Number of hours
1	Base of parts at machining. Types of bases and rules of their choice. Machine tools for machining, their classification. Universal machine tools, their types. Features of designing special machine tools.	7
2	Methods for assessing the accuracy of machining. Significance and procedure of probabilistic and statistical estimation of expected errors. Features of route and operational technologies of processing on CNC machines. Feasibility study of the technological process of dimensional processing.	7
3	Features of dimensional processing of parts from composite materials, titanium and high-strength aviation alloys. Technological features of machining of composite materials, titanium and high-strength aviation alloys. Technological features of multi-coordinate three-dimensional milling of parts. Typical trajectories of the cutter when machining the outer and inner contours of the part. Technological problems of high-speed milling.	7
4	Features of processing of parts by methods of centerless grinding and areas of their application. Electrospark and electrochemical treatment of high-strength aviation materials. The essence of processes, their features and application.	7
5	Requirements for the design of parts of aircraft, produced of sheet metal. Nomenclature of materials used in the manufacture of aerospace technology.	7
6	Nomenclature and technical characteristics of the equipment used in the manufacture of parts of aircraft from sheet. A typical technological process of making a flat part from a sheet in a tool stamp. Typical technological process of manufacturing a covering by covering from a sheet. Technological processes of making stringers from sheet.	7
7	Nomenclature and technical characteristics of the equipment used in the manufacture of parts of aircraft from profiles and pipes. Typical technological process of manufacturing a profile part by stretching with stretching. Typical technological process of manufacturing a part from a pipe billet.	7
8	Nomenclature of materials for which special methods of semi-finished product distribution and shaping are used. Equipment design and materials used to manufacture equipment.	7
9	Fourier thermal conductivity equation for point, linear, flat and three-dimensional heat source. Estimated schemes of bodies during welding. Initial and boundary conditions at thermal calculations of welded processes.	6
10	Power supplies for arc welding and requirements to them. External	6

	characteristics of power supplies and their varieties. Features of fusion welding technology of different metals. Electrodes for arc welding.	
11	Machines for contact spot and butt welding and their schemes. Features of contact welding of various metals.	6
12	Features of the formation of a welded joint in mechanical welding methods.	6
13	Classification of solders. Features of metal soldering. Safety precautions during welding.	6
14	Individual task - Term project on the topic: Development of technology for the manufacture of parts from the sheet and the design of the stamp	44
	Total hours	130

9. Individual tasks

Calculation and graphic work on development of technology for the manufacture of parts from the sheet and the design of the stamp.

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, distance learning system.

Practical training begin with an explanation using electronic didactic demonstration materials (presentations). Then training exercises are performed according to a certain pattern. An obligatory element of practical training is graphic work.

Preparation for practical classes involves the processing of lecture material and test for self-control.

Calculation and graphic works a complex practical work, which consists of calculating the parameters of the technological process, choosing the type of equipment and execution of the drawing of the device. Textbooks and methodical instructions are used for TP.

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 and the implementation of tests 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 academic work	Points for one lesson (task)	Number of classes (tasks)	Total points
Module 1			
Content module 1			
Work on lectures	0... 1	4	0... 4
Execution and protection of practical works	0 ... 3	4	0... 12
Modular control	0... 12	1	0... 12
Content module 2			
Work on lectures	0... 1	4	0... 4
Execution and protection of practical works	0 ... 4	3	0... 12
Implementation and protection of RGR	0... 12	1	0... 12
Modular control	0... 11	1	0... 11
Content module 3			
Work on lectures	0... 1	5	0... 5
Execution and protection of practical works	0 ... 4	4	0... 16
Modular control	0... 12	1	0... 12
Total for the semester			0... 100
Module 2			
Content module 4			
Work on practical classes	0 ... 2	8	0... 16
Execution and defense of the Term project	0... 84	1	0... 84
Total for the semester			0... 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 examination / credit. During the semester exam the student has the opportunity to receive a maximum of 100 points.

The exam card consists of 3 theoretical questions. The maximum number of points for a complete answer to a theoretical question is 33.3 points.

Criteria for evaluating student work during the semester

Satisfactory (60-74). Having a minimum of knowledge and skills. Work out and defend all laboratory works and individual tasks. Be able to independently determine the types of production. Know the basic operations of procurement and stamping production and dimensional processing. Know the rules of designing technological equipment.

Good (75 - 89). Firmly knowing and being able to perform the full range of tasks provided by the discipline. Demonstrate the ability to determine the quality of parts and assembly units by types of errors. Know the method of choosing the design parameters of stamped workpieces of aircraft parts. To be able to design technologies of sheet stamping and dimensional processing, and also means of technological equipment. To work out and defend all laboratory works and individual tasks in the term stipulated by the teacher with the substantiation of the decisions and actions which are offered in works.

Excellent (90 - 100). Fully knowing the basic and additional material of the discipline. Navigate in textbooks and manuals. Be able to determine the technological parameters of the production of parts by procurement and stamping production. It is reasonable to make constructive decisions about the type of stamp. Unmistakably perform and defend all laboratory work and individual tasks within the period specified by the teacher with a parted justification of the decisions and measures proposed in the works.

Distribution of points received by students for term work (project)

Explanatory Note	Illustrative Part	Work Defence	Sum
to _40_	to _40_	to _20_	100

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. Vukota Bojanovic. Sheet metal forming processes and die design. Industrial press, New York, 2004, 240p.
2. Blanking processes in aircraft manufacturing. Part 2. Tutorial for laboratory work. Borysevych V.V., Danchenko V.G., Zastela A.N., Mesheryakov A.N., Morgolenko A.S., Kharkiv, KhAI, 2009, 65p.
3. Welding / M. A. Varukha, S. M. Lashko, T. A. Yastremskaya. - Practical workbook. – Kharkiv: National aerospace university „KhAI”, 2007, 52 p.
4. Educational and methodical support of the discipline "Fundamentals of technology for the production of aerospace technology"
http://library.khai.edu/catalog?clear_all_params=0&mode=DocBibRecord&lang=ukr&caller_mode=BookList&themes_basket=&ttp_themes_basket=2099&ext=no&theme_path=0&author_fld=&docname_fld=&docname_cond=1&year_fld1=&year_fld2=&udc_fld=&isbn_fld=&lang_list=0&pubplace_fld=&publisher_fld=&bbc_fld=&issn_fld=&annotation_fld=&volume_fld=&part_fld=&responsibility_fld=&theme_cond=all_theme&littype_list=0&theme_list=0&disciplinesearch=yes&discipline_list=2099&tpage=1&step=20&faculty_list=0&department_list=4&speciality_list=0&knmz_doctype_list=39%2C40&speciality_knmz_list=27565&sillabus_list=0&knowledgearea_list=27554&qualificationlevel_list=27469&initiator_mode=KNMZ&full_searchfld=&ecopy=0&combiningAND=1&is_ttp=0&print_basket=%2C

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5. Training course "Fundamentals of aerospace production technology" in the distance learning system Mentor: <https://mentor.khai.edu/course/view.php?id=2333>
6. Training course "Fundamentals of aerospace production technology" in the distance learning system Mentor: <https://mentor.khai.edu/course/view.php?id=885>

14. Recommended reading

1. Metallurgy and Mechanics of Welding Processes and Industrial Applications. Edited by Régis Blondeau. Issued by ISTE Ltd and John Wiley & Sons, Inc., 2008. 514 pages.
2. ASM HandbookW. Volume 06A. Welding Fundamentals and Processes. Prepared under the direction of the ASM International Handbook Committee. Issued by ASM InternationalW, Materials Park, OH 44073-0002, USA, 2011. 1050 pages
3. Basics of aircraft production technology (Lecture notes in English and Russian) / V.T. Sykul'sky, Yu.A. Boborykin, S.G. Vasilchenko et al. Kharkiv: KHAI, 2006. 205 p.
4. ASM Handbook. Volume 14B. Metalworking: Sheet forming, 2006. Printed in the United States of America. 1040p.
5. KhAI Textbook, Welding. 80 p.

15. Information resources

1. Manufacturing Solutions for The Aerospace Industry. Products Brochure // MAG IAS, LLC. 2015. [Electronic resource]. - Access mode: http://exposant.technotheque.fr/files/docs/solutions-magdans-aeronautique_1294911440.pdf
2. https://t.me@aircraft_manufacturing
3. https://t.me/aircraft_manufacturing
4. <https://www.esict.com/what-is-metal-stamping/>
5. <https://www.semanticscholar.org/paper/Cnc-Machining-Handbook%3A-Building%2C-Programming%2C-and-Overby/b343830ed1472b242fcb0726ad9ec8132e662f8a>