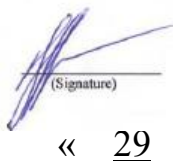
Ministry of Education and Science of Ukraine
National Aerospace University named by M. E. Zhukovsky
"Kharkiv Aviation Institute"

Technology of Aircraft Manufacturing Department (#104)

APPROVED

Head of EMC 1



Serhii NYZNYK

«__29__» ___08___ year 2023

SYLLABUS
OF OPTIONAL ACADEMIC DISCIPLINE

D4, BELONGS TO THE MINOR
"PERSPECTIVE TECHNOLOGIES IN AIRCRAFT MANUFACTURING"

Additive Manufacturing Technologies for Aviation Parts

(name of academic discipline)

Field of knowledge: 13 "Mechanical Engineering"
(code and name of field of knowledge)

Program subject area: 134 "Aerospace Engineering"
(code and name of program subject area)

Educational program: All
(name of educational program)

Mode of study: Full-time

Level of higher education: First (bachelor)

The syllabus has been implemented since 2023-2024 a. y.

Kharkiv 2023

Developer: Valeriy Sikulskiy, Professor of Department, Doctor of Technical Sciences, Docent

(full name, position, academic degree and academic title) (signature)

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

(name of department)

Protocol # 1 from " 31 " August 2022

Head of Department, Candidate of Technical Sciences (PhD), Docent — Kateryna Maiorova

(position, academic degree and academic title) (signature) (full name)

Agreed with the representative of education seekers:

(signature) (full name)

1. Description of the discipline

Lecturer – Valeriy Sikulskiy, Professor of Department #104, Doctor of Technical Sciences, Docent

Since 1980 has been teaching the following disciplines at the university:
– technology of airplane and helicopter manufacturing;
– technology of aircraft manufacturing;
– theoretical basics of aircraft manufacturing technology;
– manufacturing of aircraft parts by machining.
Areas of scientific research: shaping of aircraft parts by local deformation, technology of additive production of aircraft parts, theoretical basics of aircraft manufacturing technology.

The semester in which the discipline is taught: 8th semester.

Total number of ECTS credits: 5; **total number of hours:** 150.

Planned types of educational activities: lectures, laboratory work, independent work.

Types of control: current and final control in the form of modular work, exam.

The discipline can be studied according to the following forms of education: full-time, distance learning, dual.

Prerequisites: the condition for studying the discipline is the student's successful attestation in the following disciplines: theoretical basics of aircraft manufacturing technology, technology of structural materials.

Co-requisites: technology of aircraft manufacturing, industrial practice.

Purpose: the study of academic discipline "Technologies of Additive Manufacturing of Aircraft Parts" consists in the formation of a knowledge system, methods of activity and creative abilities from the basic methods of parts production by the additive method, from the use of materials and appropriate technological equipment, as well as the acquisition of skills that would allow to implement this knowledge in practice.

Objective: the study of materials for additive manufacturing (AM) and their effective use, the physical essence of the AM process, various types of AM, equipment for AM, structures of devices and the basics of their design, as well as learning the calculation methodology and the selection of rational modes of AM.

2. Expected learning outcomes

After mastering the discipline, the student will acquire the following **competencies**:

– the ability to analyze materials for AM, structures and processes of AM on the basis of laws, theories and methods of mathematics and natural sciences;

– the ability to make assessments of the performance parameters of materials, structures and equipment in operational conditions and to find appropriate solutions to ensure a given level of reliability of AM processes;

– the ability to carry out a technological, technical and economic assessment of the effectiveness of the use of AM technologies;

– the ability to classify processes related to AM and formulate requirements for their main parameters, which is based on deep knowledge of the theoretical and practical aspects of the processes of forming parts and structures using AM methods;

– the ability to make the optimal choice of technological equipment, complete set of technical devices, have basic ideas about the rules of the equipment operation;

– the ability to apply the conceptual and categorical apparatus, the general methodology and methods of organizing engineering activities, to analyze the needs and possibilities of production automation.

It is expected that after mastering the discipline, the student will achieve the following **learning outcomes** and he will:

– know the materials that are used for the manufacture of parts and structures using AM methods;

– know the physical basis of the main methods of AM;

– know the principles of choosing bases for the formation of parts by AM methods;

– know the process of designing the sequence of the formation of parts by AM methods;

– know the thermal processes during AM;

– know the processes of finishing parts after AM;

– know the main disadvantages and advantages of the main AM methods;

– know the main features of aerospace parts manufactured by AM methods;

– know the possible methods of increasing the productivity of AM;

– be able to choose parts and structures suitable for production on AM equipment;

– be able to choose the main technological equipment for the production of the necessary batch of parts;

– assess the technical and economic efficiency of production;

– make the optimal choice of equipment, devices and materials for AM;

– communicate freely on professional issues orally and in writing in the state language, include knowledge of special terminology and interpersonal communication skills.

Language of teaching: Ukrainian.

3. Content of the academic discipline

Module 1.

Content module 1. Basic concepts and definitions of additive technologies (AT).

Topic 1. Introduction to the academic discipline “Technologies of Additive Manufacturing of Aircraft Parts”.

Form of classes: lecture, independent work.

Volume of the classroom load: 2 hours.

Laboratory work: "Study of the department's equipment for 3D printing".

Mandatory items and means (equipment, materials, tools): absent.

The main historical stages of AT development. Basic concepts and definitions of AT.

Topic 2. 3D CAD modeling and creation of an electronic layer-by-layer image (model) of the product.

Form of classes: lecture, laboratory work, independent work.

Volume of the classroom load: 1-2 hours.

Laboratory work: "Learning the XYZware".

Mandatory items and means (equipment, materials, tools): da Vinci 2.0A Duo printer.

The concept of manufacturability of the product and parts. Types of AT. Advantages and disadvantages of AT. Prospects for AT development. Electronic models of the product.

Topic 3. FDM (Fused Deposition Modeling) – modeling by melting.

Form of classes: lecture, laboratory work, independent work.

Volume of the classroom load: 1-2 hours.

Laboratory work: "Studying the operation of the da Vinci 2.0A Duo printer".

Mandatory items and means (equipment, materials, tools): da Vinci 2.0A Duo printer.

Topic 4. CJP (ColorJet Printing) – full-color printing with the principle of gluing powder or photopolymer.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): absent.

Topic 5. SLS (Selective Laser Sintering) – laser sintering technology.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): web resources.

Topic 6. 3DW (Three-Dimensional Welding) – three-dimensional surfacing (welding), DMD (Direct Metal Deposition) – direct application of metal.

Form of classes: lecture, laboratory work, independent work.

Volume of the classroom load: 1-2 hours.

Laboratory work: "Study of technology and equipment for argon-arc surfacing".

Laboratory work: "Investigation of metal dosing methods during additive surfacing".

Mandatory items and means (equipment, materials, tools): equipment of the welding laboratory of the department.

Topic 7. LLM (Layer Laminate Manufacturing) – method of modeling by layering.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): web resources.

Topic 8. SLA (Stereo Lithographic Apparatus) – laser stereolithography.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): web resources.

Topic 9. Materials used in AT.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): web resources.

Modular control 1

Form of classes: writing a modular work in the classroom (at the decision of the lecturer, remote learning is allowed).

Volume of the classroom load: 2 hours.

Mandatory items and means (equipment, materials, tools): absent.

Content module 2. Basic characteristics of additive manufacturing.

Topic 10. Features of basing and choosing the orientation of the product in the process of its layer-by-layer build-up.

Form of classes: lecture, laboratory work, independent work.

Volume of the classroom load: 1-2 hours.

Laboratory work: "Designing the technological process of additive manufacturing".

Mandatory items and means (equipment, materials, tools): a set of parts for individual tasks.

Topic 11. Tooling and production of equipment and products – Rapid Tooling and Rapid Manufacturing.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): web resources.

Topic 12. Direct manufacturing methods.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): absent.

Topic 13. Indirect manufacturing methods.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): absent.

Topic 14. Cost-effectiveness of integrated generative technologies.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): web resources.

Comparison of traditional and additive technologies.

Topic 15. Potential and prospects for the additive technologies' development.

Form of classes: lecture, independent work.

Volume of the classroom load: 1-2 hours.

Mandatory items and means (equipment, materials, tools): web resources.

Market structure of additive technologies.

Topic 16. Basic examples of the AT use in aircraft design and cosmonautics.

Form of classes: lecture, laboratory work, independent work.

Volume of the classroom load: 6 hours.

Laboratory work: "Study of the characteristics of studded parts from aluminum alloys".

Mandatory items and means (equipment, materials, tools): equipment of the welding laboratory of the department, web resources.

Production of shell structures. Printing of structural parts of aircraft. Production of engine parts. Features of manufacturing structures of rocket and space technology.

Modular control 2

Form of classes: writing a modular work in the classroom (at the decision of the lecturer, remote learning is allowed).

Volume of the classroom load: 2 hours.

Mandatory items and means (equipment, materials, tools): absent.

4. Individual tasks

Absent.

5. Teaching methods

Verbal: story, explanation, educational discussion during consultations.

6. Methods of control

Ongoing control, modular control, final control in the form of an exam.

7. Evaluation criteria and distribution of points received by students

7.1. Distribution of points received by students

Components of academic work	Points for one class (task)	Number of classes (tasks)	Total points
Content module 1			
Activity at lectures	0…1	5	0…5
Performance and defense of laboratory (practical) work	0…4	5	0…20
Modular control	0…25	1	0…25
Content module 2			
Activity at lectures	0…1	5	0…5
Performance and defense of laboratory (practical) work	0…4	5	0…20
Modular control	0…25	1	0…25
Total for the semester			**0…100**

7.2. Accepted rating scale

Total points	Score according to traditional scale	
	Exam, term project (work), practice	Test
90 – 100	Excellent	Passed
75 – 89	Good	
60 – 74	Satisfactory	
0 – 59	Unsatisfactory (with the possibility of retaking)	Failed (with the possibility of retaking)

7.3. Criteria for evaluating student work during the semester

Satisfactory (60-74). Have a minimum of knowledge and skills to ensure program learning results. Complete and defend all laboratory works.

Good (75-89). Know the main topics of the discipline. Sufficiently know the basic processes typical for the plastics and metals 3D printing. Know the main methods of additive manufacturing, their advantages and disadvantages, understand printers and their differences. Complete and defend all laboratory works.

Excellent (90-100). Have knowledge that will allow to answer any questions independently, freely, and reasonably regarding the 3D printing processes, be able to assign 3D printing modes, to have an idea about the operation of 3D printers and their composition. Understand the materials used for 3D printing. Complete and defend all laboratory works.

8. Methodological support and web resources

Textbooks, study guides, teaching and methodical guides, lecture notes, methodical recommendations for conducting laboratory works, etc., issued by the University, are available at the links:

https://learn.ztu.edu.ua/mod/url/view.php?id=100588

https://core.ac.uk/download/pdf/159820009.pdf

The discipline page is at the link:

https://mentor.khai.edu/enrol/index.php?id=2331&lang=en

9. Recommended reading

10. Additional reading