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

«__31__» ___08___ year 2023

SYLLABUS
OF OPTIONAL ACADEMIC DISCIPLINE

D3, BELONGS TO THE MINOR
"PERSPECTIVE TECHNOLOGIES IN AIRCRAFT MANUFACTURING"

BASIC METHODS OF ADDITIVE MANUFACTURING

(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 2022-2023 a. y.

Kharkiv 2022

Developer: Kateryna Maiorova, Head of Department, Candidate of Technical Sciences (PhD), 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

From 2004 to 2011 worked at an aviation enterprise and has practical experience in technical preparation of production of aviation structures.
Since 2015 has been teaching the following disciplines at the university:
– technology of aircraft manufacturing;
– scientific and pedagogical internship;
– fundamentals of additive manufacturing;
– scientific and practical training;
– technical systems for ensuring the lifecycle of aerospace products.
Areas of scientific research: reengineering of aircraft parts, technology of additive production of aircraft parts, technology of production of aircraft parts.

The semester in which the discipline is taught: 7th semester.

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

Planned types of educational activities: lectures, laboratory 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 aircraft manufacturing.

Co-requisites: basics of technological processes simulation, technology of structural materials.

Purpose: the study of academic discipline "Basic Methods of Additive Manufacturing" 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 the formation of knowledge about the process and physical essence of the additive manufacturing process, printing modes and preparing the model for printing.

2. Expected learning outcomes

According to the requirements of the educational and professional program, students must achieve the following **competencies**:

GC4. Skills in using information and communication technologies.

GC7. Ability to make informed decisions.

GC8. Ability to learn and master modern knowledge.

SC13. The ability to assign optimal materials for structural elements of aviation and rocket and space technology.

SC16. The ability to develop and implement technological processes for the production of elements and objects of aviation and rocket and space technology.

SC17. Skills in the use of information and communication technologies and specialized software in education and professional activities.

Program learning outcomes:

PLO4. Possess the means of modern information and communication technologies in an amount sufficient for training and professional activity.

PLO5. Explain your decisions and the grounds for their acceptance to specialists and non-specialists in a clear and simple way.

PLO8. Possess the logic and methodology of scientific knowledge, which is based on an understanding of the current state and methodology of the subject area.

PLO13. Describe the structure of metals and non-metals and know methods of modifying their properties. Designate optimal materials for elements and systems of aviation and rocket and space technology, considering their structure, physical, mechanical, chemical, and operational properties, as well as economic factors.

Language of teaching: Ukrainian.

3. Content of the academic discipline

Module 1.

Content module 1. Basic concepts and definitions of aviation production.

Topic 1. Introduction to the academic discipline "Basic Methods of Additive Manufacturing".

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

Volume of the classroom load: 4 hours.

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

Mandatory items and means (equipment, materials, tools): da Vinci 2.0A Duo and CreateBot F430 printers.

The main historical stages of the additive manufacturing (AM) development. Basic concepts and definitions of AM.

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: 4 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 additive technologies (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: 4 hours.

Laboratory work: "Printing on 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, laboratory work, independent work.

Volume of the classroom load: 4 hours.

Laboratory work: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

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

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

Volume of the classroom load: 4 hours.

Laboratory work: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

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: 6 hours.

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

Mandatory items and means (equipment, materials, tools): Investigation of metal dosing methods during additive surfacing.

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

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

Volume of the classroom load: 4 hours.

Laboratory work: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

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

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

Volume of the classroom load: 4 hours.

Laboratory work: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

Topic 9. Materials used in AT.

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

Volume of the classroom load: 4 hours.

Laboratory work: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

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: 4 hours.

Laboratory work: "Designing the technological process of additive manufacturing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer, 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, laboratory work, independent work.

Volume of the classroom load: 4 hours.

Laboratory work: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

Topic 12. Direct manufacturing methods.

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

Volume of the classroom load: 4 hours.

Laboratory work: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

Topic 13. Indirect manufacturing methods.

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

Volume of the classroom load: 4 hours.

Laboratory work: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

Topic 14. Potential and prospects for the additive technologies development.

Form of classes: lecture, independent work.

Volume of the classroom load: 4 hours.

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

Market structure of additive technologies.

Topic 15. 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: "Printing on the CreateBot F430 printer".

Mandatory items and means (equipment, materials, tools): CreateBot F430 printer.

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	0.5…1	16	8…16
Performance and defense of laboratory (practical) work	1…1.5	16	16…24
Modular control	6…10	1	6…10
Content module 2			
Activity at lectures	0.5…1	16	8…16
Performance and defense of laboratory (practical) work	1…1.5	16	16…24
Modular control	6…10	1	6…10
Total for the semester			**60…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 characteristic of 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

9. Recommended reading

10. Additional reading