

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
National Aviation University
Faculty of Air Navigation, Electronics and Telecommunications
Department of Aviation Computer-Integrated Complexes

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"__" _____ 2022

APPROVED

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"__" _____ 2022



Quality management system

EXTENDED PROGRAM

on

"Graphic and Geometric Modeling and Interactive Systems"

Educational Professional Program: "Computer-Integrated Technological Processes and Production"

Field of study: 15 «Automation and Instrumentation»

Specialty: 151 "Automation and Computer-Integrated Technologies"

Training Form	Semester	Total (hours/credits ECTS)	Lectures	Pract. classes	Lab. classes	Self-study	HT/CGP/CW	TP/CP	Semester Grade
Day Form	1	120/4,0	17	-	17	86	-	-	Graded test –1 s

Index CM - 2 - 151 - 2 / 21 - 3.1



The Extended Program on «Graphic and Geometric Modeling and Interactive Systems» is developed on the basis of the Educational Professional Program «Computer-integrated technological processes and production», Curriculum and Extended Curriculum of Education Seekers Training for «Master» CM - 2 - 151 - 2/21 and ECM - 2 - 151 - 2 / 21 for the Specialty 151 "Automation and Computer-Integrated Technologies" and corresponding normative documents

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Discussed and approved by the Graduate Department for Specialty 151 «Automation and Computer-Integrated Technologies», Educational Professional Program «Computer-integrated technological processes and production» – Aviation Computer-Integrated Complexes Department, Minutes № __ of « __ » _____ 2022.

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" __ " _____ 2022

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INTRODUCTION

The Extended Program on «Graphic and Geometric Modeling and Interactive Systems» is developed on the basis of "Methodical instructions for the development and design of the Extended Program for the subject", enacted by the order as of 29.04.2021 № 249/od and corresponding normative documents.

1. EXPLANATORY NOTE

1.1. Place, objectives, tasks of the subject.

The place of the subject «Graphic and Geometric Modeling and Interactive Systems» in the system of professional training.

The educational subject refers to the disciplines of free choice of students. The discipline is the theoretical basis of the set of knowledge and skills that form the profile of a specialist in the field of automation and computer-integrated technologies.

The aim of teaching the discipline is to provide future specialists with the basics of scientific and theoretical knowledge and practical skills in graphic and geometric modeling and experience working with interactive systems.

Tasks of the discipline are:

- study and practical implementation of software tools for creating and processing computer images
- study of geometric modeling methods and algorithms;
- formation of practical skills in creating, configuring and maintaining graphic systems.

1.2. Learning outcomes the subject makes it possible to achieve.

The study of an academic discipline involves the formation of the following program learning outcomes:

- solve typical problems of graphic and geometric modeling of technical processes and devices;
- to design and implement highly reliable pilotage and navigation complexes of aircraft and their application software, for the implementation of management and information processing functions.

1.3. Competences the subject makes it possible to acquire.

As a result of studying this discipline, the student acquires the following program competencies:

- 3K2 - the ability to generate new ideas (creativity).
- 3K3 - ability to abstract thinking, analysis and synthesis.;
- CK2 - the ability to design and implement highly reliable automation systems and their application software;
- CK8 - the ability to develop the functional, technical and informational structure of computer-integrated control systems using network and information technologies and human-machine interface tools.

1.4. Interdisciplinary connections.

The educational discipline «Graphic and Geometric Modeling and Interactive Systems» interacts with the discipline «Methods of Modeling and Optimization of Systems and Processes», which is studied in parallel with it and complements each other.



2. COURSE TRAINING PROGRAM ON THE SUBJECT.

2.1. The subject content

The educational material of the subject «Graphic and Geometric Modeling and Interactive Systems» is structured on a modular principle and consists of two educational modules, namely:

- educational **module No. 1 "Mathematical models in graphic design"**;
- educational **module No. 2 "The main types of images of 3-dimensional objects on a plane"**, each of which is logically complete, independent and integral part of the curriculum. Its mastering has in view module test and analysis of its completion.

2.2. Modular structuring and integrated requirements for each module

Module No. 1 "Mathematical models in graphic design"

Integrated requirements of module No 1:

Know:

- geometric and dialog graphic models of the object;
- coordinate systems and geometric transformations.

Be able:

- choose appropriate software for working with graphics systems.

Topic 1. Geometric and graphic modeling. Machine graphics tools

The history of the emergence and development of computer graphics (CG). The specificity of geometric problems in CG. Problems of dialog interaction of the user with the computer. Concept of mathematical model. Direct and rotary problems of mathematical modeling.

Topic 2. Machine graphics as a CAD subsystem. The position of graph theory

Graphical CAD systems are focused on drawings. Functions and components of graphic CAD systems. Technical means of the interactive graphic system. Software architecture of graphic systems. Concept of approximation and interpolation. The main list of problems solved using graph theory.

Topic 3. Mathematical models in design

The role of mathematical models in design. Image model. Graphic primitives. The connection between the general, geometric and dialog graphic model of the object.

Topic 4. Coordinate systems and geometric transformations

Absolute, relative, world, physical and normalized coordinates. Homogeneous coordinates. Affine coordinate system. Geometric transformations.

Module No. 2 "The main types of images of 3-dimensional objects on a plane"

Integrated requirements of module No 2:

Know:

- mathematical foundations of geometric modeling;
- methods of forming the structure and shape of geometric objects.

Be able:

- solve typical problems of graphic and geometric modeling.

Topic 1. Framing and clipping operations

The concept of a window. Species transformation. D. Cohen and A. Sutherland's algorithm for selecting visible segments. Hyphenation. Scaling: full and partial. Rotation to an arbitrary angle relative to the origin. The relationship between coordinate transformation and image transformation.



Topic 2. **Mathematical foundations of geometric modeling**

Generalized matrix of transformations for three-dimensional homogeneous coordinates. Description of rotation around an arbitrary axis. Features of transformation of three-dimensional images into two-dimensional ones.

Topic 3. **Perspective images**

Concept of picture plane. The effect of shortening linear dimensions in a perspective image. Advantages and disadvantages of a perspective image. Axonometric projection. Main sunrise point.

Topic 4. **Presentation of the structure and shape of geometric objects**

Methods of forming three-dimensional (stereoscopic) images. Problems of geometric modeling. Presentation of the structure and shape of geometric objects. Representation of curved lines. Bezier form. Form of B-splines.

2.3. Training schedule of the subject.

№	Topic	Academic hours			
		Total	Lectures	Lab. classes	Self-study
Module №1 «Mathematical models in graphic design»					
1.1	Geometric and graphic modeling. Machine graphics tools	1 semester			
		14	2	2	10
1.2	Machine graphics as a CAD subsystem. The position of graph theory	14	2	2	10
1.3	Mathematical models in design	14	2	2	10
1.4	Coordinate systems and geometric transformations	14	2	2	10
1.5	Module test 1	3	1	-	2
Total for Module 1		59	9	8	42
Module №2 «The main types of images of 3-dimensional objects on a plane»					
2.1	Framing and clipping operations	15	2	2	11
2.2	Mathematical foundations of geometric modeling	14	2	2	10
2.3	Perspective images	15	2	2	11
2.4	Presentation of the structure and shape of geometric objects	14	2	2	10
2.5	Module test 2	3	-	1	2
Total for Module 2		61	8	9	44
Total for the discipline		120	17	17	86



3. BASIC CONCEPTS OF GUIDANCE ON THE SUBJECT

3.1. Teaching methods

Both subject-oriented and individually-oriented learning technologies are used to activate the educational and cognitive activity of students during the study of the discipline. Laboratory work mainly uses the Case Study method, and lectures and presentations and interactive learning technologies are used.

3.2. List of references

Basic literature

- 3.2.1 Braid, I.C., R.C. Hillyard and I.A. Stroud. Stepwise Construction of Polyhedra in Geometric Modeling," in Mathematical Methods in Computer Graphics and Design, K.W. Brodlie, ed., Academic Press, P.P. 123 -141.
- 3.2.2 Philip J. Schneider and David H. Eberly (2002). Geometric Tools for Computer Graphics. Morgan Kaufmann.
- 3.2.3 Atsuyuki Okabe, Barry Boots, Kokichi Sugihara, and Sung Nok Chiu (2000). Spatial Tessellations: Concepts and Applications of Voronoi Diagrams (2nd ed.). John Wiley & Sons.
- 3.2.4 Giri Narasimhan; Michiel Smid (2007). Geometric Spanner Networks. Cambridge University Press. ISBN 0-521-81513-4.
- 3.2.5 Петренко А.И., Семенков О.И. Основі побудови систем автоматизованого проектування. – К.: Вища шк., Головне изд-во, 1995.-294с.

Additional literature

- 3.2.6 Kurt Mehlhorn and Stefan Näher (1999). LEDA, A Platform for Combinatorial and Geometric Computing. Cambridge University Press. ISBN 0-521-56329-1.
- 3.2.7 Системи автоматизованого проектування: типові елементи, методи і процеси / Під ред. Д.А.Аветисяна. – К.: Изд-во стандартів, 1985.-180с.

3.3 Information resources on the Internet

- 3.3.1 http://dic.academic.ru/dic.nsf/enc_tech/1559/
- 3.3.2 http://www.razlib.ru/tehnicheskije_nauki/sverhzvukovye_samolety
- 3.3.3 <http://www.flxsys.com/aerospace.shtml>



4. RATING SYSTEM OF KNOWLEDGE AND SKILLS ASSESSMENT

4.1. Assessment of certain types of academic work performed by the student is carried out in points in accordance with table 4.1.

Table 4.1

Type of Academic Work	Maximum Grade Values	Type of Academic Work	Maximum Grade Values
Semester №1			
Module №1 «Mathematical models in graphic design»		Module № 2 «The main types of images of 3-dimensional objects on a plane»	
Execution and defending laboratory works (total)	$56 \times 4 = 20$	Execution and defending laboratory works (total)	$56 \times 4 = 20$
Execution of tasks of express control under time of laboratory classes	$46 \times 4 = 16$	Execution of tasks of express control under time of laboratory classes	$46 \times 4 = 16$
<i>For carrying out module test №1, a student must receive not less than</i>	22	<i>For carrying out module test №2, a student must receive not less than</i>	22
Module Test №1	14	Module Test №2	14
Total for the Module 1	50	Total for the Module 2	50
Total for modules 1, 2			100
Total for the subject			100

The credit rating is determined (in points and on a national scale) based on the results of all types of educational work during the semester.

4.2. The kind of academic work, performed by a student, has been passed, if a student got positive grade.

4.3. The grades a student has been given for the different kinds of academic work the summed up and the result constituting a Current Module Grade is entered into the Module Grade Register.

4.4. In the case of **Graded test**, the sum of the final semester module grade in points constitutes the final semester rating grade, which is converted into a grade based on the national scale and the ECTS scale.

4.5. The Total Semester Grade is entered into the credit and examination information, the study card and into the student's record book, for example: **92/Ex/A**, **87/Good/B**, **79/Good/C**, **68/Sat/D**, **65/Sat./E**, etc.

4.6. The Total Subject Grade corresponds to the Total Semester Grade. The Total Subject Grade is entered in the Diploma Supplement.



(Ф 03.02 – 01)

АРКУШ ПОШИРЕННЯ ДОКУМЕНТА

№ прим.	Куди передано (підрозділ)	Дата видачі	П.І.Б. отримувача	Підпис отримувача	Примітки

(Ф 03.02 – 02)

АРКУШ ОЗНАЙОМЛЕННЯ З ДОКУМЕНТОМ

№ пор.	Прізвище, ім'я, по батькові	Підпис ознайомленої особи	Дата ознайомлення	Примітки

(Ф 03.02 – 04)

АРКУШ РЕЄСТРАЦІЇ РЕВІЗІЇ

№ пор.	Прізвище, ім'я, по батькові	Дата ревізії	Підпис	Висновок щодо адекватності

(Ф 03.02 – 03)

АРКУШ ОБЛІКУ ЗМІН

№ зміни	№ листа (сторінки)				Підпис особи, яка внесла зміну	Дата внесення зміни	Дата введення зміни
	Зміненого	Заміненого	Нового	Анульованого			

(Ф 03.02 – 32)

УЗГОДЖЕННЯ ЗМІН

	Підпис	Ініціали, прізвище	Посада	Дата
Розробник				
Узгоджено				
Узгоджено				
Узгоджено				