Ministry of Education and Science of Ukraine
National Aerospace University
"Kharkiv Aviation Institute"

Department of Descriptive Geometry and Computer Modeling (№ 406)

APPROVED
Vice Head of educational program

M. Romanov
«31» 08 2021

GRADUATING PROGRAM OF THE DISCIPLINE

Geometric modeling and graphic information technologies
(title of discipline)

Field of Study: 13 “Mechanical engineering”, 14 “Electrical Engineering” 15 “Automation and instrumentation”, 27 “Transport”
(code and title of the field of study)

Program Subject Area: 134 “Aerospace engineering”, 131 “Applied Mechanics”, 133 “Industrial Machinery Engineering”, 141 "Electric power, electrical engineering and electromechanics", 142 "Power Engineering", 144 "Heat Power Engineering", 151 "Automation and computer-integrated technologies", 272 "Air transport", 274 "Road transport"
(code and title of the program subject area)

Educational program: “Design and manufacturing of composite structures”, “Maintenance and repair of aircraft and aircraft engines”, "Design, manufacture and certification of aircraft", "Cars and automotive", "Gas turbines and compressor stations", "Robotomechanical systems and logistics systems", "Aircraft Engines and Power Plants ", "Technologies for the Production of Aircraft Engines and Power Plants ","Computer-aided Design and Production Technologies","Energy Management "," Computer-Integrated energy systems design technologies ”,“Unmanned aerial vehicles ”, “ Rocket engines and power plants ”, “Rocket and space systems ”, “Satellites, engines and power plants”, “ Non-traditional and Renewable Energy Sources ”.
(title of educational program)

Mode of study: Full-time
Degree: First (Bachelor)

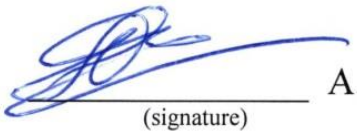
Kharkiv 2021

Developed by:
Head of Descriptive Geometry and Computer Modeling Department, PhD

_____ A. Cherniavskyi
(signature)

The educational program was considered at the meeting of Descriptive Geometry and Computer Modeling Department (№406), protocol № 1 dated 31.08.2021

Head of the Descriptive Geometry and
Computer Modeling Department (406)



_____ A. Cherniavskyi
(signature)

1. Discipline syllabus

<table>
<tr><td rowspan="2">Indicator</td><td rowspan="2">Field of study,
subject area,
educational program,
degree</td><td colspan="2">Characteristics
of the discipline</td></tr>
<tr><td colspan="2">Full-time</td></tr>
<tr><td>Credits – 10</td><td rowspan="15">Field of study
13 “Mechanical engineering”, 14 “Electrical Engineering”, 15 “Automation and instrumentation”, 27 “Transport”
(code and title)
Program subject area
“Design and manufacturing of composite structures”, “Maintenance and repair of aircraft and aircraft engines”, "Design, manufacture and certification of aircraft", "Cars and automotive", "Gas turbines and compressor stations", "Robotomechanical systems and logistics systems", "Aircraft Engines and Power Plants ", "Technologies for the Production of Aircraft Engines and Power Plants ","Computer-aided Design and Production Technologies","Energy Management "," Computer-Integrated energy systems design technologies ”,“Unmanned aerial vehicles ”, “ Rocket engines and power plants ”, “Rocket and space systems ”, “Satellites, engines and power plants”, “ Non-traditional and Renewable Energy Sources ”.
(code and title)
Educational program:
“Design and manufacturing of composite structures”, “Maintenance and repair of aircraft and aircraft engines”, "Design, manufacture and certification of air-</td><td colspan="2">Training cycle (optional)</td></tr>
<tr><td>Modules – 2</td><td colspan="2">Academic year</td></tr>
<tr><td>Content modules – 3</td><td colspan="2">2021 / 2022</td></tr>
<tr><td rowspan="2">Individual assignments
_____
_____
(title)</td><td colspan="2">Semester</td></tr>
<tr><td>1-st</td><td>2-nd</td></tr>
<tr><td rowspan="2">Total hours – 160/300</td><td colspan="2">Lectures[2)]</td></tr>
<tr><td>32 hours</td><td>16 hours</td></tr>
<tr><td rowspan="2">Weekly hours for full-time study[1)]:
- classroom –5
- individual student work – 4,375</td><td colspan="2">Practices, seminars[2)]</td></tr>
<tr><td>24 hours</td><td>32 hours</td></tr>
<tr><td colspan="2">Laboratory[2)]</td></tr>
<tr><td>24 hours</td><td>32 hours</td></tr>
<tr><td colspan="2">Individual work</td></tr>
<tr><td>80 hours</td><td>80 hours</td></tr>
<tr><td colspan="2">-</td></tr>
<tr><td>–</td><td>–</td></tr>
<tr><td colspan="2">Type of control</td></tr>
<tr><td>exam</td><td>exam</td></tr>
</table>

	craft", "Cars and automotive", "Gas turbines and compressor stations", "Robotomechanical systems and logistics systems", "Aircraft Engines and Power Plants ", "Technologies for the Production of Aircraft Engines and Power Plants ","Computer-aided Design and Production Technologies","Energy Management "," Computer-Integrated energy systems design technologies ",“Unmanned aerial vehicles ”, “ Rocket engines and power plants ”, “Rocket and space systems ”, “Satellites, engines and power plants”, “ Non-traditional and Renewable Energy Sources ” **Degree** First (bachelor)		

Note:

[1)] The ratio of the classroom hours to hours of the independent and individual work for full-time education is 1/1.

[2)] Classroom load can be reduced or increased by one hour depending on the schedule.

2. The purpose and objectives of the discipline

The purpose of the study: mastering the basic principles of geometric modeling, methods of displaying spatial forms on the plane, standards of design documentation, mathematical and algorithmic foundations of computer graphics.

Objectives: development of spatial representation and imagination, constructive-geometric thinking, ability to analyze and synthesize spatial forms and relationships, study methods of constructing various geometric spatial objects (mainly surfaces), ways to obtain their drawings as graphic models, the ability to solve tasks related to spatial objects in these drawings.

Acquiring competencies:

General competencies:

K04. Skills in the use of information and communication technologies.
K05. Ability to work in a team.
K06. Ability to generate new ideas (creativity).
K07. Ability to make informed decisions.
K08. Ability to learn and acquire modern knowledge.

Special (professional) competencies:

K17. Skills in the use of information and communication technologies and specialized software in teaching and professional activities.

Learning outcomes: Apply modern methods of design, construction and production of elements and systems of aviation and rocket and space technology in professional activities.

As a result of studying the discipline the student should

know:

- means of depicting spatial forms on the plane;
- theory of construction of technical drawings;
- modern standards of computer graphics;
- logic of organization in graphic software;

be able to:

- use the means of spatial forms depicting in the plane;
- use the theory of technical drawings construction;
- use graphic software for geometric modeling and development of design documentation;
- create and read technical diagrams, drawings and sketches of parts, assemblies and units of machines, assembly drawings and drawings of general view, etc.;

has an idea of:

- basic terms, concepts and methods of engineering graphics and computer modeling;
- ways to represent spatial objects in a plane.

Prerequisites:

To master the discipline successfully, the student should have basic training in geometry, drawing, computer science within the high school program.

Co-requisites:

When studying the discipline, it is desirable to know the basics "Materials Science" and "Interchangeability and Standardization".

Postrequisites:

The principles and methods studied in the course are related to basics of engineering and widely used throughout all student learning process. Mastering of this course is necessary for the courses "Machine Parts", "Mechanics of Materials", "Technical Mechanics" and others. It's also important for laboratory works, course projects and explanatory notes, diploma project.

3. Discipline program

Module 1. Descriptive Geometry.

Topic 1. Projection. Monge's drawing. Axonometric method of projection.
Topic 2. Orthographic projection of and relative position of geometric objects.
Topic 3. Polyhedrons.
Topic 4. Transformation of a Drawing.
Topic 5. Curves.
Topic 6. Surfaces. Ruled Surfaces. Surfaces of revolution.
Topic 7. Positional problems on the surfaces.
Topic 8. Developments.
Topic 9. Modern CAD technologies.

Module 2. Engineering Graphics and CAD technologies.

Topic 1. Basics of standardization for Design Documentation. Views. Section views. Sections. Dimensioning.

Topic 2. Screw Threads. Thread representation in a drawing. Threaded Fasteners. Temporary and Permanent joints.

Topic 3. Drawings of Machine Parts. Work drawings.

Topic 4. Types of products and design documents. Stages of product design. Sketching. Assembly drawing. General view drawing.

Topic 5. 3D Modelling. Types of 3D-models. Parametric Modeling.

Topic 6. Construction of 2D drawings from 3D models.

Topic 7. Assembly modelling. Standard elements and parts. BOM.

Topic 8. 3D Modelling of Sheet metal parts. Basics of Surface modelling.

4. Discipline structure

Modules and topics	Hours					
	total	including				
		lec	prac	lab	indiv	indep
1	**2**	**3**	**4**	**5**	**6**	**7**
Module 1. Descriptive Geometry.						
Submodule 1. A point. Aline. A plane. Polyhedrons.						
Topic 1. Projection. Monge's drawing. Axonometric method of projection.	18	4	2	4	–	8
Topic 2. Orthographic projection of and relative position of geometric objects.	30	8	10	-	–	12
Topic 3. Polyhedrons.	8	2	–	2	–	4
Topic 4. CAD systems. Plane Primitives.	4	–	–	2		2
Topic 5. CAD. Modifying of plane constructions.	8	–	–	4	–	4
Total for submodule 1	**68**	**14**	**12**	**12**	**0**	**30**
Submodule 2. Curves. Surfaces. Positional problems.						
Topic 1. Transformation of a Drawing.	16	4	4	–	–	8
Topic 2. Curves.	8	2	2	–	–	4
Topic 3. Surfaces. Ruled Surfaces. Surfaces of revolution.	18	4	2	4	–	8
Topic 4. Positional problems on the surfaces.	24	4	4	4	–	12
Topic 5. Developments.	8	2	–	2	–	4
Topic 6. 3D Modelling. Types of 3D-models.	8	2	-	2	-	4
Total for submodule 2	82	18	12	12	0	40
Total for module 1	**150**	**32**	**24**	**24**	**0**	**70**
Module 2. Engineering Graphics and CAD technologies.						
Topic 1. Basics of standardization for Design Documentation. Views. Section views. Sections. Dimensioning.	20	2	8	–	–	10
Topic 2. Screw Threads. Thread representation in a drawing. Threaded Fasteners. Temporary and Permanent joints.	24	6	8	–	–	10
Topic 3. 3D Modelling. Modifying of 3D-models. Parametric Modeling.	28	2	–	14	–	12
Topic 4. Construction of 2D drawings from 3D models.	18	–	–	8	–	10
Topic 5. Drawings of Machine Parts.	26	2	8	6	–	10
Topic 6. Types of products and design documents. Stages of product design. Sketching. Assembly drawing. General view drawing.	18	2	8	–	–	8
Topic 7. Assembly modelling. Standard elements and parts. BOM.	16	2	–	4	–	10
Total for module 2	**150**	**16**	**32**	**32**	**0**	**70**
Total	**300**	**48**	**56**	**56**	**0**	**140**

5. Practical classes

№	Title	Hours
	Module 1. Descriptive Geometry	
1	Introduction to a course program, Basic statements of Engineering Drawing and Design Documentation.	2
2	Projection. Properties of projection.	1
3	Orthographic and axonometric projection of a point.	2
4	Orthographic projection of a straight line.	1
5	Orthographic projection of a plane. Polyhedrons.	2
6	Metric problems with elementary geometric objects.	1
7	Transformation of a drawing. Projection on auxiliary planes.	2
8	Transformation of a drawing. Revolution about an axes perpendicular to the principal plane. Plane-parallel motion.	1
9	Orthographic projection of curves.	2
10	Orthographic projection of surfaces of revolution.	2
11	Orthographic projection of linear surfaces. Ruled surfaces. Helicoidal surfaces.	2
12	Positional problems on the curved surfaces. Section of curved surfaces. Intersection of a line and a curved surface.	2
13	Intersection of surfaces	2
14	Development of surfaces	2
	Total for module 1	**24**
	Module 2. Engineering Graphics and CAD technologies	
1	Orthographic Drawing. Views. Sectioned views. Sections. Model “400”	4
2	Dimensioning. Conventional designations.	2
3	Orthographic Drawing. Offset and Aligned sectioned views. Sections. Detailed views.	2
4	Fastenings and joints. Thread and threaded joints. Bolt joint.	2
5	Fastenings. Stud and screw joints.	2
6	Shaft. Purpose, standard shaft elements and their conventional representation in a drawing.	4
7	Types of products and design documents. Stages of product design. Assembly drawing. Joints in assembly unit.	2
8	Sketching. General view drawing. Main view. Number of views. Sectioned views. Sections. Detail views.	2
9	Sketching of constituent parts of the unit except standard ones.	4
10	Gearing. Purpose, types, structural elements. Spur gears. Conventional representation and drawings.	2
11	Assembly Drawing. Purpose. Structure. Content. Representation. Conventional designations in assembly drawing.	2
12	Assembly Drawing of a gear joint. Specification. Bill of materials.	4
	Total for module 2	**32**
	Total	**56**

6. Laboratory works

№	Title	Hours.
	Module 1. Descriptive Geometry	
1	CAD systems. Introduction. AutoCAD. Settings. Layers. Line Types. Model and Paper space drawing.	2

2	AutoCAD objects. Primitives.	6
3	AutoCAD. Editing of objects. Object Snap. Dimensions.	8
4	AutoCAD. Plane contour. Dimensioning. Elements of Parameterization.	4
5	AutoCAD. 3D modelling.	2
	Total for module 1	**24**
	Module 2. Engineering Graphics and CAD technologies	
1	Autodesk Inventor. Objects. Profiles. Sketches. Constraints. 3D modeling of machine parts.	16
2	Autodesk Inventor. Drawings from 3D models.	4
3	Autodesk Inventor. 3D Assembly modelling.	6
4	Autodesk Inventor. Drawings from 3D assemblies. Presentations.	6
	Total for module 2	**32**
	Total	**64**

7. Self-study

№	Title	Hours.
	Calculation and graphic work 1	
1	Descriptive Geometry. Projection to a plane. Monge's drawing. Axonometric drawing.	8
2	Orthographic projections. Polyhedrons.	16
3	Transformation of a drawing. Curve lines.	12
4	Surfaces. Ruled surfaces. Surfaces of revolution. Intersection of surfaces. Monge's theorem.	10
5	Developments.	8
	Calculation and graphic work 2	
6	Basics of standardization for Design Documentation. Views. Section views. Sections. Dimensioning.	10
7	Screw Threads. Thread representation in a drawing. Threaded Fasteners. Temporary and Permanent joints.	10
8	Drawing of typical machine parts	18
9	Computer Graphics. Object representation in computer graphics. Geometric models.	10
10	CAD systems	32
	Total	**140**

8. Individual assignments

1. Calculation and graphic work №1 consists of the following graphic works performed during the first semester: "Title page", "Contour", "Polyhedrons", "Curved lines and surfaces", "Positional problems on surfaces ". Completed works are bound in the Album of drawing assignments.
2. Calculation and graphic work №2 consists of the following graphic works performed during the second semester: "Projection drawing. Views, sections, section views", "Joints of machine parts. Thread fastening. Bolt joint. Stud and screw joint", "Drawings of typical machine parts. Shaft. Fitting. Body part. Spring. Gear", "General view drawing", "Assembly drawing. Specification. BOM". Completed works are bound in the Album of drawing assignments.

7. Teaching methods

Conducting lectures, practical classes, individual consultations (if necessary), independent work of students on the materials published by the department (methodical manuals), calculation work.

8. Control methods

Carrying out of current control in the form of performance of practical works, written modular control, control of performance of settlement work, final control in the form of examination.

9. Evaluation criteria and points distribution

Quantitative evaluation criteria (distribution of points). Module 1.

Components of educational work	Points for one class (task)		Number of classes (tasks)	Total number of points	
	min	max		min	max
Submodule 1					
Lectures	-	-	-	-	-
Practical classes	-	-	-	-	-
Laboratory works	0	5	3	0	15
Graphic works	0	5	3	0	15
Modular control №1	0	15	1	0	15
Total for submodule 1				0	45
Submodule 2					
Lectures	-	-	-	-	-
Practical classes	-	-	-	-	-
Laboratory works	0	5	4	0	20
Tests	0	5	2	0	10
Graphic works	0	5	2	0	10
Modular control №2	0	15	1	0	15
Total for submodule 2				0	55
Total for module 1				**0**	**100**

Mandatory condition for crediting the points obtained by the module-rating system, as a final control is the implementation and defending of individual work "Calculation and graphic work №1" (Album of drawing assignments). During the semester exam the student has the opportunity to get a maximum of 100 points.

The obligatory condition for admission to the semester control is the performance of all types of compulsory work "Calculation and graphic work №1" (Album of drawing assignments). 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 (performance and protection of settlement work). The exam is conducted in the form of testing with examination cards. The set of control tasks consists of 4 problems on the above mentioned Topics. The maximum number of points for each correct answer to the test problem is 25 points.

Quantitative evaluation criteria (distribution of points). Module 2.

Components of educational work	Points for one class (task)		Number of classes (tasks)	Total number of points	
	min	max		min	max
Lectures	-	-	12	-	-
Practical classes	-	-	16	-	-
Laboratory works	0	5	3	0	15
Graphic works	0	5	3	0	15
Modular control №1	0	15	1	0	15
Total for submodule 1				0	45
Module 2					
Lectures	-	-	8	-	-
Practical classes	-	-	16	-	-
Laboratory works	0	5	3	0	15
Tests	0	5	4	0	20
Graphic works	0	5	8	0	40
Modular control №2	0	25	1	0	25
Total for module 2				**0**	**100**

Mandatory condition for crediting the points obtained by the module-rating system, as a final control is the implementation and defending of individual work "Calculation and graphic work №2" (Album of drawing assignments). During the semester exam the student has the opportunity to get a maximum of 100 points.

The obligatory condition for admission to the semester control is the performance of all types of compulsory work "Calculation and graphic work №2" (Album of drawing assignments). 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 (performance and protection of settlement work). The exam is conducted in the form of testing with examination cards. The set of control tasks consists of 2 problems on the above mentioned Topics. The maximum number of points for each correct answer to the test problem is 50 points.

Qualitative evaluation criteria (required amount of knowledge and skills).

Module 1.

The required amount of knowledge to obtain a positive assessment:

the student should know the essence of the method of orthogonal projections, theoretical foundations and methods of orthogonal and axonometric projections of objects in a space, graphic techniques for solving problems of geometric design, mainly related to determining the shape, relative position and mutual intersection of geometric objects in the drawings.

The required amount of skills to obtain a positive assessment:

the student should understand the basic methods of design; be able to solve metric and positional problems; be able to restore from flat projection images spatial objects; solve problems using the basic methods of transforming a complex drawing; use these techniques when performing specific problems in a drawing. Perform graphic work within the curriculum.

Module 2.

The required amount of knowledge to obtain a positive assessment:

the student should know the theoretical foundations of geometric and projection drawings, proper standards and requirements for machine drawings.

The required amount of skills to obtain a positive assessment:
the student should be able to read and perform graphic works within the curriculum in accordance with the requirements for technical and design documentation.
the student should be able to use computer graphics means to perform graphic work with the help of CAD systems that saves the time gives more conveniences and opportunities for design work.

Criteria for evaluating student work for the semester.

Module 1.

Satisfactory (60… 74). Show minimum of knowledge and skills. Pass all modular tasks.
The student knows theoretical foundations of plane images construction with insufficient understanding of its essence and logical relationship with the requirements of standards, algorithms for solving positional and metric problems, but makes mistakes in their use in practice, has some skills on graphic technical documentation.

Good (75… 89). Firmly know the minimum, pass all modular tasks and additional extracurricular independent work.
The student knows theory of construction of plane images of three-dimensional objects, understanding of its essence. Has skills and abilities to apply it in practice, typical tasks on plane images are performed independently. Has knowledge of the requirements of standards.

Excellent (90… 100). Pass all control measures and additional extracurricular independent work with a grade of "excellent". Thoroughly know the information on all topics and be able to apply it.
The student knows and deeply understands theoretical foundations of three-dimensional objects modeling on the plane, standards and requirements for the design documentation. Has the ability to offer an original way to solve problems of synthesis, analysis and processing of plane images by creating new combinations of previously known algorithms for designing forms of technical parts. Has skills in graphic design documentation with the help of modern graphic systems and according to the standards.

Module 2.

Satisfactory (60… 74). Show minimum of knowledge and skills. Pass all modular tasks.
The student has mastered the basic concepts and statements of the course, but is unsure of the standards for design documentation, additional questions cause uncertainty or lack of knowledge. He is unsure in CAD program. Graphic works are performed with errors (no sections or cross-sections in the views, not enough dimensions are placed). No complete answer for the control tests.

Good (75… 89). Firmly know the minimum, pass all modular tasks and additional extracurricular independent work. The student has mastered the basic concepts and principles of the discipline, freely uses the acquired theoretical knowledge performing graphic works, but allows certain inaccuracies and errors in the execution of drawings. The student has mastered the theoretical material on the relevant topic, on the implementation of graphic works. Graphic works are performed according to the standards, but minor errors had been made when drawing the dimensions in accordance with the requirements. He knows CAD program, performs tasks for self-study. Correctly gives answers to knowledge control tests.

Excellent (90… 100). Pass all control measures and additional extracurricular independent work with a grade of "excellent". Thoroughly know the information on all topics and be able to apply it.
The student has mastered the theoretical material of the course, basic rules of drawing construction according to the standards, as well as is able to use reference literature, technical documentation. Performs all graphic work in accordance with the standards, correctly performs tasks, gives correct answers to control tests.
He knows CAD program, namely can create 3D models of machine parts and assembly units, uses parametric modeling tools, can use libraries and CAD applications, as well as create design documentation for 3D models and assembly units.

Assessment scale: national and ECTS

The sum of points for all types of educational activities	Score by a national scale
90 – 100	Excellent
83 – 89	good
75 – 82	
68 – 74	satisfactory
60 – 67	
1 – 59	unsatisfactory; allows additional attempts

10. Methodical support

Methodical instructions for performance and tasks for practical work, as well as for graphic calculation work.

11. Recommended Books

1. James H. Earle. Engineering Design Graphics: Pearson/Prentice Hall, New York, 2008.
2. Frederick E. Giesecke, Alva Mitchell, Henry Cecil Spencer, Ivan Leroy Hill, John Thomas Dygdon, James E. Novak, Shawna Lockhart. Technical Drawing. New Jersey: Pearson Education, 2009.
3. V.O.Gordon. A Course in Descriptive Geometry/ V.O. Gordon, M.A. Sementsov-Ogievskii – Moscow: Mir, 1980.
4. Andrii Cherniavskyi, Yurii Litvin, Tygran Muradyan, Oleksandr Sidachenko. Problems on descriptive geometry. Kharkov: KhAI, 2017.
5. Joints of machine parts / Andrii Y Cherniavskyi, Andrii V Chumachenko, Katerina P. Msallam, Oksana I. Panchenko, Natalia V. Perekhrest, Zinaida O. Pogorelova, Oleksander A. Sidachenko – Manual. – Kharkov: National Aerospace University "Kharkiv Aviation Institute", 2017. – 108 p.
6. Shafts and gears. Representation in a drawing [Text]: manual / Andrii Y. Cherniavskyi, Andrii V. Chumachenko, Kateryna P. Msallam, Oksana I. Panchenko, Nataliia V. Perekhrest, – Kharkiv : National Aerospace University «Kharkiv Aviation Institute», 2019. – 84 p.
7. Workbook on Engineering Graphics / A.Y. Cherniavskyi, A.V. Chumachenko, T.K. Muradyan, N.V. Perekhrest, – Kharkiv: National Aerospace University «Kharkiv Aviation Institute», 2020. – 136 p.
8. Чернецький М.М. Лекції з нарисної геометрії: Навч. посібник. – Київ: ІСДО, 1995. – 295 стор.
9. Technical Descriptive Geometry / B.L. Wellman. – NY: McGraw-Hill, 1957.

12. Information resources

Website of the department **http://k406.khai.edu**