

ENGINEERING AND COMPUTER GRAPHICS

Working program of the academic discipline (Syllabus)

Details of the academic discipline

Level of higher education	<i>First (undergraduate)</i>
Branch of knowledge	<i>13 Mechanical engineering</i>
Specialty	<i>131 Applied mechanics</i>
Educational program	<i>Packaging and packaging equipment engineering</i>
Discipline status	<i>Normative</i>
Form of education	<i>Full-time (day) /remote/mixed</i>
Year of training, semester	<i>1st year, autumn semester</i>
Scope of the discipline	<i>4(120)</i>
Semester control/ control measures	<i>Assessment</i>
Lessons schedule	<i>Lecture – once a week (36 hours); Practical classes – once every two weeks (18 hours); Computer workshop - once every two weeks (18 hours).</i>
Language of teaching	<i>Ukrainian</i>
Information about head of the course / teachers	<i>Department of descriptive geometry, engineering and computer graphics (building 7, room 815),, e-mail: http://geometry.kpi.ua/ Phone:+380 44 204 94 46 Lecturer: Dr. technical Sciences, Professor Virchenko Gennadii Anatoliyovych, kpivir@gmail.com Practical: according to the schedule. Laboratory: according to the schedule.</i>
Placement of the course	<i>Link to distance resource (Moodle) https://www.sikorsky-distance.org</i>

Program of educational discipline

1. Description of the educational discipline, its purpose, subject of study and learning outcomes

Drawings are the main means of expressing technical thought. They should not only determine the shape and dimensions of technical products, but also be quite simple and accurate in graphic design, help comprehensively explore various objects, their individual elements. In order to correctly express your requirements with the help of a drawing, sketch or draftsman, you need knowledge of the theoretical foundations of constructing images of geometric figures, the relationships between them, which is the subject of engineering graphics and its component - sketch geometry, which is the basis for solving the tasks of technical drawing.

The study of engineering graphics contributes to the development of creative spatial imagination, constructive and geometric thinking, the ability to analyze and synthesize spatial forms, their relationships. The methods of constructing geometric objects, making their drawings in the form of graphic models and the ability to solve metric and positional problems on these drawings allow to significantly increase the professional level of the future technical specialist.

The goal of mastering the discipline "Engineering and computer graphics" is the formation of students of higher education with the knowledge and skills necessary for the execution and reading of technical documentation, which is an indispensable condition for the design and operation of automation systems.

The tasks of studying the discipline "Engineering and computer graphics":

- *mastering the basics of the methods of depicting spatial forms on a plane;*
- *the study of geometric properties of objects and their mutual location in space;*
- *practical mastering of techniques and methods of execution of various technical drawings;*
- *mastering the basics of algorithmization and automation of work performance;*
- *creation and design of design documentation using AutoCAD CAD and application of standards requirements. A student of higher education must:*

know:

- *methods and techniques of projection drawing; rules for execution and reading of design and technological documentation;*
- *drawing rules, geometric constructions of technical products; methods of graphical representation of technological equipment;*
- *the requirements of the standards of the Unified Design Documentation System for the design of drawings and schemes.*

be able:

- *perform graphic images of technological equipment and schemes in manual and machine modes; read and execute drawings of technical products;*
- *draw up technological and design documentation in accordance with current standards.*

The goal of the educational discipline is the formation of competencies in students of higher education:

- *ability to abstract thinking, analysis and synthesis (ZK1);*
- *knowledge and understanding of the subject area, professional activity (ZK2);*
- *the ability to identify, pose and solve problems (ZK3);*
- *ability to apply knowledge in practical situations (ZK4);*
- *the ability to learn and master modern knowledge (ZK7);*
- *skills in using information technologies (ZK9);*
- *the ability to analyze materials, structures and processes based on the laws, theories and methods of mathematics (FC1);*
- *the ability to use computerized design systems (CAD) to solve engineering problems in applied mechanics (FC7);*
- *ability to spatial thinking, reproduction of spatial objects, structures and mechanisms in the form of projection drawings and three-dimensional geometric models (FC8);*
- *the ability to present the results of one's engineering activities in compliance with generally accepted norms and standards (FC9);*
- *perform geometric modeling of details, mechanisms and structures in the form of spatial models and projection images and prepare the result in the form of technical and working drawings (RN5);*
- *apply regulatory and reference data to control compliance of technical documentation, products and technologies with standards, technical conditions and other regulatory documents (RN7);*
- *skills in the practical use of computerized design systems (CAD) (PH12).*

2. Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

Engineering graphics is a discipline that has no analogues and predecessors, based on knowledge of elementary geometry and drawing acquired in high school. It is the first degree of training of applicants, which explains the basic rules for the execution and design of design documentation, which ensures the mastery of geometric modeling of specific engineering products in the preparation of a bachelor of technical profile.

Engineering and computer graphics provide applicants with the basics of fundamental knowledge and skills in the field of geometric modeling, on the basis of which the future bachelor can successfully study such disciplines as the theory of mechanisms and machines, machine parts and the basics of construction, materials and equipment for the manufacture of polymer packages, engineering calculations on a personal computer, the basics of packaging design, the basics of using CAD/CAM/CAE, as well as performing the graphic part of course and diploma projects.

3. Content of the academic discipline

Chapter 1. Projection methods

Introduction. Subject and tasks of the course. Its place is in the complex of disciplines for engineering training of bachelors and masters in the field of automation, computer-integrated technologies and robotics.

Topic 1.1. Projection methods. Central and parallel projection. Point projection. Complex point plotter. Methods of constructing the third projection of a point. Position of points relative to projection planes. Definition of a straight line on the plot. Lines of individual and general position. Belonging of a point to a straight line. The method of replacing projection planes. The relative position of two straight lines.

Topic 1.2. Modeling the plane. Definition of the plane on the epur. Planes of a separate position. Planes of general position. Belonging to a line and a point in a plane. Determination of the natural size of a flat figure. Curved lines. Circle projection.

Topic 1.3. Axonometric projections. The essence of axonometric projection. Distortion coefficients. Construction of rectangular axonometric projections (independently).

Chapter 2. Geometric modeling of surfaces

Topic 2.1. Surfaces. Methods of determining surfaces, their classification. Surfaces of rotation. Construction of points and lines on the surface, conditions for their belonging to the surface.

Topic 2.2. Intersection of surfaces with a plane. General method of intersection of surfaces with a plane. Construction of the line of intersection of second-order surfaces by planes of a special position. Determination of the natural size of the cross-sectional figure. Sweeps.

Topic 2.3. Single penetration. General method of solving problems for single penetration of surfaces by symmetric and asymmetric horizontal "windows" (independently).

Section 3. Basic types of design documents and rules for their design

Topic 3.1. The system of ESCD standards - the main provisions. Formats. Scales. Lines. Fonts. Geometric drawing. Conjugation of geometric elements. Basic requirements for drawing dimensions on the drawing.

Topic 3.2. Projection drawings. Main images. Views, sections, sections. Classification of cuts. Simple cuts: horizontal, vertical, oblique. Complex cuts: stepped, broken and combined. Peculiarities of their implementation. The main provisions of the standards regarding the application of dimensions.

Topic 3.3. Sketches and working drawings of details. Incision. Classification of threads. Image and designation of the thread on the drawing. A detail with a thread. Cleanliness of the surface of the part. Conventions for marking roughness on drawings.

Topic 3.4. Connection of parts: threaded, gluing, soldering, welding. Assembly drawing board.

Topic 3.5. Compilation of the product specification.

Chapter 4. Computer graphics systems

Topic 4.1. Launch AutoCAD. Graphical program interface. The main menu of the program. Context menu. Using dialog boxes. Toolbars. Working with the command line. Program modes. Definition of coordinates in AutoCAD. Commands for building graphic primitives. Step-by-step binding. Object binding. Creating a new drawing. Saving the drawing. Using templates.

Topic 4.2. Setting the parameters of the draftsman in AutoCAD. Means of organization of the draftsman. Working with layers. Layer parameters: color, type, line thickness, etc. Control the image on the screen. Working with text. One-line text. Multiline text. Text style settings. Image editing commands.

Topic 4.3. Drawing flat objects of complex shape. Conjugation of geometric elements. Work with polyline. Working with splines. Construction of flat contours. Customizing Dimension Styles. Applying dimensions. Drafting according to the requirements of basic standards (formats, scales, lines, fonts, etc.).

Topic 4.4. Construction of a projection drawing of the part. Determination of points by methods of auxiliary constructions: tracking, point filters, From operations. Drafting of the projection drawing of the part (views, sections, drawing of dimensions, notation of sections, etc.).

Topic 4.5. Modeling of three-dimensional objects. Creating a three-dimensional model by pushing out. Application of contours and areas. Use of axonometric images. Methods of cutting the fourth part of the model. Boolean operations. User coordinate system. Hatching of sections of three-dimensional objects.

Topic 4.6. Modeling of three-dimensional objects by rotation method. Design of the 3D model of the "Cover" type part,

Topic 4.7. Construction of basic views from the model space. Automatic creation of sections, isometric image of the part on the drawing.

4. Educational materials and resources

Basic literature

1. Khmelenko O.S. *Descriptive geometry. Textbook.* K.: Condor, 2008. 440 p. https://ng-kp.kpi.ua/files/Literature/hmelenko_o_s_narisna_geometriya.pdf
2. *Engineering graphics. A collection of problems and methodical recommendations for studying the discipline for students of the chemical and technological faculty, the medical and biological engineering faculty, the electronics faculty [Electronic resource]: education. manual for students specialties 161 "Chemical technology and engineering", 151 "Automation and computer-integrated technologies", 171 "Electronics", 172 "Telecommunications and radio engineering"/ KPI named after Igor Sikorskyi; compilers: A.E. Izvolenska, D.K. Ludanov, G.S. Lift up – Electronic text data (1 file: 35 MB).* Kyiv: KPI named after Igor Sikorskyi, 2018. 94 p. http://ng-kp.kpi.ua/files/Tetrad2012_20_4_protected.pdf
3. Vanin V.V., Bliok A.V., Hnitetska G.O. *Preparation of design documentation: training. manual* Kyiv: Caravela, 2013. 160 p. http://ng-kp.kpi.ua/index.php?option=com_content&view=article&id=208:oformlennjavanin&catid=2:vanin&Itemid=5.
4. *Engineering graphics. Development of working drawings and sketches of details. Study guide / Compilers: V.V. Vanin, O.M. Vorobyov, A.E. Izvolenska, N.A. Parakhina.* Kyiv: NTUU "KPI", 2009. 104 p. <https://ng-kp.kpi.ua/files/development-w-drawings.pdf>
5. Baskova G.V., Koval H.M. *Methodical instructions for completing the task on the topic "Connection".* Kyiv: NTUU "KPI named after Igor Sikorskyi", 2017. 42 p. <http://ng-kp.kpi.ua/files/147.pdf>
6. Vanin V.V., Perevertun V.V., Nadkernychna T.O. *Computer engineering graphics in the AutoCAD environment Study. manual.* Kyiv: Caravela, 2006. 336 p. https://ng-kp.kpi.ua/files/vanin_perevertun_nadkernichna_komp.pdf
7. *Methodical guidelines for geometric and projection drawing / Compiled by H.M. Blacksmith.* Kyiv: NTUU "KPI", 2014. 36 p. http://ng-kp.kpi.ua/files/metod_kovalj.pdf

The specified literature is available in a sufficient amount in the library of Igor Sikorsky KPI.

Information resources

A short course of lectures on engineering graphics <http://ela.kpi.ua/handle/123456789\6764>
Campus <https://ecampus.kpi.ua/>

Educational and methodological literature of the department https://ng-kp.kpi.ua/index.php?option=com_content&view=article&id=619&Itemid=32

Educational content

5. Methods of mastering an educational discipline (educational component)

The program of the academic discipline provides for lectures and practical classes. Methodical support for studying the course is the use of information resources that present an appropriate set of materials: lecture course; video lessons; workbook, both in printed version and in electronic version. In the case of distance learning, all these materials can be used during lectures and practical classes on the Zoom platform, etc., and also be available when organizing independent work of students within the framework of remote access to information resources at a time convenient for them.

Lectures

The purpose of the lectures is to reveal the above topics. In addition, recommendations are formulated regarding the proper use of the presented material in practical classes. Clarifications are provided regarding difficult-to-understand provisions, students are motivated for their further fruitful studies.

Lecture topics for the credit module:

Lecture 1. Introduction. Point projection.

Lecture 2. Modeling of straight lines.

Lecture 3. Projection of a plane and a circle.

Lecture 4. Curved lines and surfaces.

Lecture 5. Intersection of surfaces by a plane. Sweeps.

Lecture 6. Single penetration.

Lecture 7. Intersection of surfaces.

Lecture 8. Basic types of design documents.

Lecture 9. General rules for designing drawings.

Lecture 10. Types. Sections. Sections.

Lecture 11. Applying dimensions.

Lecture 12. Structural and technological elements of parts.

Lecture 13. Cuts. Classification.

Lecture 14. Execution of working drawings of threaded parts.

Lecture 15. Peculiarities of execution of drawings of parts of the "Shaft" type.

Lecture 16. Assembly drawings. Specifications.

Lecture 17. Detachable and non-detachable connections.

Lecture 18. Assessment.

Practical training

The purpose of practical classes is an in-depth study of the topics of the credit module, a detailed examination by students of its individual theoretical provisions, the formation of abilities and skills of their practical application through individual performance of relevant tasks.

Approximate topics of practical classes:

- Projection methods. Point projection. Straight line projection. The method of replacing projection planes.
- Plane projection. The relative position of two planes. Curved lines. Circle projection.
- Surfaces. Methods of determining surfaces, their classification. Surfaces of rotation. Construction of points and lines on the surface, conditions for their belonging to the surface.
- Intersection of surfaces by a plane. Sweeps.
- General rules for the design of drawings (formats and basic inscriptions, scales, lines, font, general rules for applying dimensions, etc.).
- Images: views, sections, sections. Execution of the model draft.
- Slice. Execution of working drawings of parts with threading. Surface roughness parameters.
- Execution of assembly drawings.

Computer workshop

The main goal of the computer workshop is to acquire a set of knowledge and skills in the construction and design of electronic blueprints of technical objects, as well as their modeling with AutoCAD CAD tools.

Approximate list of computer workshops:

- Introduction to CAD AutoCAD, initial settings. Work with graphic primitives. bindings Drawing by layers.
- Editing commands, image management. Working with text. Creation of templates.
- Sizing. Formation of dimensional styles. Using templates. Layout of a flat outline drawing.
- Work with polylines and splines. Construction of contours and regions. Hatching. Conjugation Execution of drawings of details of complex shape.
- Creation of a drawing of a part (views, sections, dimensioning) using tracking operations and object bindings.
- Modeling of three-dimensional models using the push-out method. Using the user's local coordinate system.
- Simulation of three-dimensional models by rotation method.
- Creation of a detail drawing from a three-dimensional model.

Individual tasks

In order to deepen the study of the educational material of the discipline and acquire practical skills, works based on individual initial data are provided, the purpose of which is:

- consolidation of theoretical provisions of topics and sections of the discipline;
- verification of the level of assimilation of knowledge received by students during lectures, practical classes and a computer workshop, as well as during independent work on the course.

According to the curriculum, 3 graphic works are provided, which are performed according to a mixed system (in practical classes and independently):

- 1) "Sections are simple";
- 2) "Cap nut";

3) "Shaft";

and 4 graphic works of the computer workshop:

1) "Outline of the part";

2) 3D modeling. Pushing out";

3) 3D modeling. Rotation;

4) 3D modeling. Combined method.

In the learning process, in addition to traditional methods of teaching new material and monitoring students' knowledge, active and collective learning strategies are used, which are determined by the following methods and technologies:

1) elements of the methods of problem-based learning: posing the problem and interviewing about ways to solve it during the lecture presentation of the material;

2) personal-oriented (developmental) technologies based on active forms and methods of education: conducting discussions on the topics of the most effective methods of solving classroom tasks and building working drawings according to the general drawing, choosing the main image, using sections to reproduce the internal structure of details;

3) information and communication technologies that ensure the problem-research nature of the learning process and the activation of students' independent work: electronic presentations for lecture classes, the use of audio and video support for educational classes.

6. Independent work of the student

Processing of lecture materials. Doing homework in the workbook for each topic.

Execution of individual tasks: sketches, blueprints and sketches of details.

Two weeks are allotted for each task.

Appropriate methodical documentation has been developed for the organization of the student's independent work in practical, laboratory classes and when performing individual tasks. This is a workbook, video lessons from a computer workshop, methodological instructions and training manuals that cover all course topics, methodological maps, reference tables, options for individual tasks, samples of graphic works, etc.

Policy and control

7. Policy of academic discipline (educational component)

The study of the academic discipline "Engineering and computer graphics" requires the student of higher education:

- observance of educational and academic ethics;

- implementation of the schedule of the educational process;

- be attentive in classes;

- systematically study theoretical material;

- compliance with the schedule for the protection of graphic works, while the applicant's answer must demonstrate the independence of the task, the absence of signs of plagiarism.

Incentive points are assigned by the lecturer for active work at lectures (answers to the lecturer's questions), participation in the Olympiad in engineering graphics, early defense of individual tasks.

Penalty points are charged for late completion of individual tasks (one week or more late).

Academic integrity

The policy and principles of academic integrity are defined in Chapter 3 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorsky Kyiv Polytechnic Institute". More details: <https://kpi.ua/code>

Norms of ethical behavior

Norms of ethical behavior of students of higher education and employees are defined in Chapter 2 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute". More details: <https://kpi.ua/code>

The procedure for contesting the results of control measures

Applicants for higher education have the opportunity to raise any issue related to control measures and expect it to be dealt with according to pre-defined procedures.

8. Types of control and rating system for evaluating learning outcomes (ELO)

Current control

The student's credit module rating consists of the points he receives for:

- 1) work in practical classes (tasks in a notebook);
- 2) execution of graphic works;
- 3) computer workshop;
- 4) modular control work;
- 5) incentive points.

System of rating points

1. Practical classes.

1.1 **Exercise book** (assignment), (total 20 points).

In practical classes, students work with a notebook in which they perform tasks on 4 topics, each of which is evaluated at a maximum of 5 points.

Rating points system and evaluation criteria:

- correct solution of problems 5 points
- minor errors 4 points
- partial solution of problems and minor errors 3 points
- gross errors 1 ... 2 points
- failure to perform 0 points

Work in the notebook is credited $(\sum \text{min}) * 12$ points

1.2. Graphic works.

In practical classes and during independent work, students perform 3 graphic works (total 30 points):

1. "Simple cuts" - 10 points
2. "Cap nut" - 10 points;
3. "Shaft" - 10 points.

Rating points system and evaluation criteria:

- complete independent performance 9 ... 10 points
- independent performance, minor errors 7 .. 8 points
- execution with errors that are corrected during consultation with the teacher 5 ... 6 points
- gross errors 1 ... 4 points
- failure to perform 0 points

Graphic works are credited $(\sum \text{min}) * 18$ points

1.3. Computer workshop (max 40 points in total):

1. "Detail outline" -- 10 points;
2. "3D modeling. Pushing out" - 10 points;
3. "3D modeling. Rotation" - 10 points;
4. "3D modeling. Combined method" - 10 points.

Rating points system and evaluation criteria:

- complete independent performance 9 ... 10 points
- independent performance, minor errors 7 .. 8 points
- execution with errors that are corrected during consultation with the teacher 5 ... 6 points
- gross errors 1 ... 4 points
- failure to perform 0 points

Computer workshop credited $(\sum \text{min}) * 24$ points

*Subject to availability of all drafters

1.4 **Modular control work.** During the semester, there are 2 test papers in practical classes, each of which is evaluated at a maximum of 5 points, that is, a student can receive a maximum of 10 points.

1. "Point, straight line";
- 2, "Surfaces" (points on the surface);

Rating points system and evaluation criteria:

- complete answer (at least 90% of the required information) 5 points

- a complete answer (at least 75% of the required information), or a complete answer with minor errors 4 points

- incomplete answer (at least 60% of the required information) 3 points

- less than 60% of the required information 0 .. 2 points

Incentive points.

Students who faithfully attended lectures and practical classes and actively worked on them, receive an additional 10 incentive points to the semester rating:

- 5 points for conscientious work at lectures;

- 5 points for conscientious work in practical classes and timely defense of graphic works.

Students who participated in the Olympiad in the discipline "Engineering graphics" receive incentive points depending on their positive achievements in this Olympiad.

Penalty points.

The work, which the student handed in late (a week or more late) without valid reasons, is evaluated with a factor of 1/2.

The maximum number of points a student can score is 100:

Workbook of practical classes	Graphic works	Computer workshop	Control works	Incentive points	The maximum amount of points
20	30	40	10	10	100

Calendar control (attestation)

I Attestation According to the results of 7 weeks of study, a student can score a maximum of 43 points. The student receives "credited" according to the results of the first certification (8th week), if his current rating is at least 25 points.

II Attestation According to the results of 13 weeks of study, a student can score a maximum of 78 points. At the second certification (14th week), the student receives "credited" if his current rating is at least 45 points.

Assessment

To receive credit "automatically" it is necessary to have at least 60 rating points. For this, all tasks must be completed and positively evaluated:

– notebook of practical classes, not less than 12 points;

– an album of graphic works, at least 18 points;

– computer workshop, at least 24 points.

The obtained rating points are translated into grades:

Rating points	Traditional assessment
95-100	perfectly
85-94	very good
75-84	fine
65-74	satisfactorily
60-64	enough
< 60	unsatisfactorily
Non-fulfillment of conditions of admission to semester control	not allowed

Students who at the end of the semester have a rating of less than 60 points, as well as those who want to improve their rating, complete credit work.

Students with a rating of less than 40 points are not allowed to take the test.

The credit work ticket consists of two practical problems on the topics "Simple sections" and "Replacing projection planes", the performance of each of which is estimated at a maximum of 10 points.

The system of rating points and the criterion for evaluating credit work:

"excellent" - complete solution of problems, compliance with the terms of registration 19-20 points

"good" - minor errors 16-18 points

"satisfactory" - tasks completed with errors, but not less than 60% 12-15 points

"unsatisfactory" - tasks not completed, or completed less than 60% 0-11 points

All previous points received by the student during the semester are canceled and this rating point is final.

Rating points are translated into grades:

<i>Final check work</i>	<i>Rating points</i>	<i>Traditional assessment</i>
<i>19-20</i>	<i>95-100</i>	<i>perfectly</i>
<i>17-18</i>	<i>85-94</i>	<i>very good</i>
<i>16</i>	<i>75-84</i>	<i>fine</i>
<i>13-15</i>	<i>65-74</i>	<i>satisfactorily</i>
<i>12</i>	<i>60-64</i>	<i>enough</i>
<i>0-11</i>	<i><60</i>	<i>unsatisfactorily</i>
<i>Non-fulfillment of conditions</i>	<i>Non-fulfillment of conditions</i>	<i>not allowed</i>

Working program of the academic discipline (syllabus):

Compiled by Dr. of technical sciences, Prof. Virchenko G.A. and Senior teacher Lazarchuk M.V.

Approved by the Department of descriptive geometry, engineering and computer graphics (protocol No. 6 dated 05/25/2023)

Agreed by the Methodical Commission of the Faculty of Engineering and Chemistry (protocol No. 10 dated 05/26/2023)