



# ENGINEERING AND COMPUTER GRAPHICS

## Syllabus

### Requisites of the discipline

Level of high education	<i>First (bachelor's)</i>
Branch of knowledge	16 Chemical engineering and Bioengineering
Specialty	163 Biomedical Engineering
Educational program	Medical engineering
Status of the discipline	Normative
Learning form	full-time / day / mixed / remote
Semester	1h year, autumn semester
Course scope	4 credits / 120 hours
Semester control / control measures	Exam, modular control work
Schedule	According to the schedule on the website <a href="http://rozklad.kpi.ua/">http://rozklad.kpi.ua/</a>
Language	English
Information about course supervisor and lecturers	<p><b><u>Lecturer:</u></b> Associate Professor of Biomedical Engineering, PhD of Technical Sciences, Dubko Andrii Grigorovich, <a href="http://intellect.kpi.ua/profile/dag5">intellect.kpi.ua/profile/dag5</a>; <a href="http://www.nas.gov.ua/UA/PersonalSite/Pages/default.aspx?PersonID=0000016737">http://www.nas.gov.ua/UA/PersonalSite/Pages/default.aspx?PersonID=0000016737</a> <a href="http://orcid.org/0000-0001-6070-3945">http://orcid.org/0000-0001-6070-3945</a> <a href="https://www.scopus.com/authid/detail.uri?authorId=55226164600">https://www.scopus.com/authid/detail.uri?authorId=55226164600</a>.</p> <p><b><u>Practical:</u></b> Associate Professor of Biomedical Engineering, PhD of Technical Sciences, Dubko Andrii Grigorovich, <a href="http://intellect.kpi.ua/profile/dag5">intellect.kpi.ua/profile/dag5</a>; <a href="http://www.nas.gov.ua/UA/PersonalSite/Pages/default.aspx?PersonID=0000016737">http://www.nas.gov.ua/UA/PersonalSite/Pages/default.aspx?PersonID=0000016737</a> <a href="http://orcid.org/0000-0001-6070-3945">http://orcid.org/0000-0001-6070-3945</a> <a href="https://www.scopus.com/authid/detail.uri?authorId=55226164600">https://www.scopus.com/authid/detail.uri?authorId=55226164600</a>.</p>
Course placement	<b>Sikorsky Platform - course "Engineering and computer graphics"</b>

### Curriculum of the discipline

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

The subject of the discipline "Engineering and Computer Graphics" is to form students' understanding of the principles, skills and practical abilities to learn the basics of engineering graphics.

The purpose of teaching the discipline is to provide students with theoretical knowledge and the formation of practical skills in the ability to solve complex specialized problems and practical problems of creation, operation, and testing of medical devices with sensors and converters.

*The purpose of teaching the discipline is to provide students with theoretical knowledge and the formation of practical skills to solve complex specialized problems and practical problems of creating designs of medical devices. The primary task of an engineering drawing is to create and enhance an object into structure and understand the various difficulties' which may arise while translating the model into prototype projected in real world.*

*The objectives of the discipline are:*

- mastering the general principles of use of regulations used for engineering graphics;*
- analysis of the current state of engineering graphics;*
- mastering knowledge of: lines; methods determining the size; geometric design.*
- mastering knowledge of: projection theory; fastening; rivets; welded joints.*
- mastering knowledge of computer graphics.*

**General competencies** (OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024):

**GC 1** - Ability to apply knowledge in practical situations.

**GC 3** - Ability to communicate in the official national language both orally and in writing.

**GC 4** - Skills in using information and communication technologies.

**GC 5** - Ability to conduct research at an appropriate level.

**GC 6** - Ability to search, process, and analyze information from various sources.

**GC 7** - Ability to generate new ideas (creativity).

**GC 8** - Ability to make informed decisions.

**Special (professional) competencies** (OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024):

**PC 1** - Ability to apply engineering software packages for research, analysis, processing, and presentation of results, as well as for automated design of medical devices and systems.

*The program learning outcomes after studying the discipline "Engineering and computer graphics" are (OPP was put into effect by the Rector's Order NON/434/2024 of 10.06.2024):*

**PLO 01** - *The ability to apply knowledge of the fundamentals of mathematics, physics and biophysics, bioengineering, chemistry, engineering graphics, mechanics, materials resistance and strength, properties of gases and liquids, electronics, computer science, signal and image acquisition and analysis, automatic control, system analysis, and decision-making methods at a level necessary for solving biomedical engineering tasks.*

**PLO 16** - *Ability to utilize computer-aided design and drafting systems for developing the technological and hardware schematics of medical devices and systems, taking into account the specifics of their components.*

## **2. Prerequisites and post-requisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)**

***The discipline "Engineering and computer graphics" belongs to the cycle of professional training and has an interdisciplinary nature. It integrates according to its subject knowledge from other disciplines. According to the structural and logical scheme of the training program, the discipline " Engineering and computer graphics" is closely related to other disciplines in modern research in the specialty, including disciplines: Fundamentals of computer science; Fundamentals of discrete mathematics; Object-oriented programming.***

### **3. The content of the discipline**

*The main sections and topics that will be considered in the process of studying the course:*

#### **Section 1. Introduction to Drawing as a Language of Engineers and Drawing Equipments**

*Topic 1.1. Drawing as a Language of Engineers .*

*Topic 1.2 Importance of Technical Drawing to an Engineer (creating designs, reading designs, modifying designs, manufacturing).*

*Topic 1.3. Significance of Engineering Drawing.*

*Topic 1.4. Scope of Engineering Drawing in Technical World.*

*Topic 1.5. Application of Manual Drawing Instruments.*

*Topic 1.6 Important Drawing Equipments and Their Uses.*

*Topic 1.7 Set of Drawing Instruments. Drawing Sheet Layout.*

#### **Section 2. Computer graphic.**

*Topic 2.1. The 21st Century in the Engineering Product Design Computer Graphics.*

*Topic 2.2. impact of Computer Technologies on Graphical Communication.*

*Topic 2.3. Importance of 3D modelling in Mechanical Engineering.*

*Topic 2. 4. Comparison of 3d modeling software.*

*Topic 2. 5. Solidworks.*

*Topic 2. 6 .FreeCAD.*

*Topic 2. 7 . Kompas-3D.*

#### **Section 3. Lines and Conventional Breaks**

*Topic 3.1. Types of Lines and Their Applications.*

*Topic 3.2. Detailed Description and Uses of Lines (Border Lines, Visible Lines, Hidden Lines, Centre Lines, Extension and Dimension Lines, Leaders, Short Break Lines. Cutting Plane Lines, Section Lines, Phantom Lines)*

*Topic 3.3 Conventional Breaks*

#### **Section 4. Lettering Techniques and Dimensioning with Tolerances.**

*Topic 4.1. General Proportions of Lettering.*

*Topic 4.2. Rules of Lettering.*

*Topic 4.3. Dimensioning Technology.*

*Topic 4.4. Form Tolerances.*

*Topic 4.5. Material Condition Modifiers.*

#### **Section 5. Geometrical Construction.**

*Topic 5.1. Important Terms which are Used in Geometrical Construction (surface, point, line, angle ).*

*Topic 5.2. Polygon.*

*Topic 5.3. Bisecting a Straight Line.*

*Topic 5.4. To Divide a Line into Many Equal Parts.*

*Topic 5.5. To Bisect an Angle between Two Given Lines.*

*Section 6. Engineering Curves.*

*Topic 6.1. Conic Section.*

*Topic 6.2. Ellipse.*

*Topic 6.3. Parabola.*

*Topic 6.4 . Hyperbola.*

*Topic 6.5 . Involute.*

*Topic 6.6 . Special Curves.*

### **Section 7. Scales.**

*Topic 7.1. Full Scale. Reducing Scale. Enlarge Scale.*

*Topic 7.2. Units of measurements (Metric System, English System).*

### **Section 8. Theory of Projection.**

*Topic 8.1. Projections of Points. Projection of Lines.*

*Topic 8.2 . Projection of Plane. Traces of Plane.*

*Topic 8.3. Oblique Planes.*

*Topic 7.4. Auxiliary View.*

### **Section 9. Projection of Solid.**

*Topic 9.1. Types of Solid.*

*Topic 9.2. Polyhedra.*

*Topic 9.3 Other Forms of Solids.*

*Topic 9.4 Position of Solid.*

### **Section 10. Orthographic Projection.**

*Topic 10.1. Theory of Orthographic Projection.*

*Topic 10.2. Comparison between First Angle Projection and Third Angle Projection.*

*Topic 10.3. Selection of Views.*

### **Section 11. Sectional Views.**

*Topic 11.1. Cutting Plane Lines.*

*Topic 11.2. Rules of Sectioning.*

*Topic 11.3. Types of Sectional Views.*

### **Section 12. Isometric Projection.**

*Topic 12.1. Axonometric Projection. Isometric Scale.*

*Topic 12.2. Methods of Making an Isometric Projection or View.*

### **Section 13. Screw Threads, Fasteners.**

*Topic 13.1. Terminology of a Screw Thread.*

*Topic 13.2.*

*Topic 13.3. Fastening Fasteners.*

*Topic 13.4. Types of Nuts.*

*Topic 13.5. Types of Bolts.*

*Topic 13.6. Screws.*

### **Section 14. Rivets and Riveted Joints. Welded Joint.**

*Topic 14.1. Types of Riveted Heads.*

*Topic 14.2. Types of Riveted Joints.*

*Topic 14.3. Welding Processes.*

*Topic 14.4. Types of Welded Joints.*

*Topic 14.5. Elements of Welding Symbol.*

#### 4. Training materials and resources

Basic literature, which should be used to master the discipline, is developed independently to prepare for practical classes and in the context of distance learning. It is suggested to use additional literature and Internet resources to perform modular tests, prepare reports, presentations, write essays based on the results of independent work.

1. *Engineering Graphics and Design*. Dr. Mohd. Parvez, Osama Khan. First Edition. New Delhi-2019. – 406 p.
2. K. Rathnam. *A First Course in Engineering Drawing*. Springer Nature Singapore Pte Ltd. 2018. – 387 p.
3. Godfrey C. Onwubolu. *Introduction to SOLIDWORKS. A Comprehensive Guide with Applications in 3D Printing*. by Taylor & Francis Group 2017. – 1165 p.
4. Denis Bobylev. *Comparison of 3d modeling software*. Saimaa University of Applied Sciences Faculty of Technology, Lappeenranta 2017. – 64 p.
5. Theodore J. Branoff. *Interpreting Engineering Drawings, Eighth Edition*. Illinois State University 2016. -514p.
6. *Engineering Drawing and Design, Fifth Edition*. David A. Madsen, David P. Madsen. Delmar. 2012. – 1298 p.
7. P. Kannaiah, K.L. Narayana, K. Venkata Reddy. *Machine drawing. Third Edition*. New Age International Ltd., Publishers, 2006.- 451 p.

#### Additional literature:

1. Colin H. Simmons, Dennis E. Maguire. *Manual of Engineering Drawing. Second edition*. Elsevier 2004.-290 p.
2. K. Venkata Reddy. *Textbook of Engineering Drawing. Second Edition*. BS Publications 2008. -377p.
3. Sandeep Singh. *Beginning Google SketchUp for 3D Printing*. Apress 2010.-309 p.
4. *Medical Devices and Systems .The Electrical Engineering Handbook Series*. Edited by Joseph D. Bronzino. Trinity College Hartford, Connecticut, U.S.A. – 2006. – 1404p.
5. *ENGINEERING METROLOGY AND MEASUREMENTS*. N.V. RAGHAVENDRA, L. RISHNAMURTHY. Oxford University Press 2013. – 531 p.

### Educational content

#### 5. Methods of mastering the discipline (educational component)

No s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
1.	<i>Important Drawing Equipments and Their Uses.</i>	PLO 24	Practical work 1	1-2nd week
2.	<i>Comparison of 3d modeling software.</i>	PLO 24	Practical work 2	3-4th week
3.	<i>General Proportions of Lettering.</i>	PLO 24	Practical work 3	5-6th week
4.	<i>Full Scale. Reducing Scale. Enlarge Scale.</i>	PLO 24	Practical work 4	7-8th week
5.	<i>Projection of Plane. Traces of Plane.</i>	PLO 24	Practical work 5	9-10th week
6.	<i>Types of Sectional Views.</i>	PLO 24	Practical work 6	11th week
7.	<i>Forms of Screw Threads.</i>	PLO 24	Practical work 7	12-13th week
8.	<i>Modular control work</i>	PLO 24	Writing a modular test	14th week
9.	<i>Abstract</i>	PLO 24	Registration and submission of work	15-16th week

## **6. Independent student work**

*One of the main types of semester control during the mastering of the discipline "Engineering and computer graphics" is the implementation of the abstract. The abstract is performed in accordance with the requirements, within the period specified by the teacher.*

*The main purpose of the abstract is to solve a theoretical problem using the theoretical material learned in lectures and independently studied. The student can write an essay only on a topic agreed with the teacher.*

### **Approximate topics of abstracts:**

- №1 Computer graphic.*
- №2 Projection of Solid*
- №3 Orthographic Projection.*
- №4 Screw Threads,*
- №5 Rivets and Riveted Joints.*
- №6 Welded Joint.*

*The title page of the abstract should have the following content: the name of the university; name of the faculty; name of department; name of specialty, name of educational-professional program, name of academic discipline; topic of the abstract; last name and first name of the student, course, number of the academic group, year.*

*The title page is followed by a detailed plan (content) of the abstract, which should highlight the introduction, sections of the main content (main topics studied), their subdivisions (if necessary), conclusion, list of sources used. The table of contents on the right indicates the page numbers at the beginning of each question. Each section begins on a new page.*

*The total volume of the abstract, depending on the chosen topic, can vary from 15 to 20 pages of the main text (in agreement with the teacher). The volume of the abstract is determined by the student's ability to briefly and comprehensively explain the results.*

*Mandatory requirement: clear reference to sources of information. All figures, facts, opinions of scientists, quotations, formulas must have a reference in the form [2, p. 54] (the first digit means the number of the source in the bibliography given at the end of the creative work, and the second digit - the page number in this source). It is desirable to use tables, diagrams, graphs, charts, etc. The list of used sources (not less than 10 sources) is made out according to operating rules. If the information is taken from the Internet, you need, as for ordinary literature, to indicate the author, the title of the article, and then provide the address of the site on the Internet.*

*The abstract is evaluated by the following criteria: logic of the plan; completeness and depth of disclosure of the topic; reliability of the received data; reflection of practical materials and results of calculations; correctness of formulation of conclusions of the received results and conclusions; design; substantiation of the student's own opinion on this issue in the form of a conclusion.*

*Deadline for submission of abstracts for review: 16th week of study.*

*The abstract is not tested for plagiarism, but must meet the requirements of academic integrity. In case of academic dishonesty, the work is canceled and not checked.*

## 7. Policy of academic discipline (educational component)

### Attending classes

Attendance at lectures is optional. Attending practical classes is desirable, as they are used to write express tests / tests, as well as to defend practical work.

The grading system is focused on obtaining points for student activity, as well as performing tasks that are able to develop practical skills and abilities.

### Control measures missed

Missed control measures (defense of practical work) must be practiced in the next classes, provided that the task scheduled for the current lesson or consultations.

Omissions of writing a module test and express test are not fulfilled.

The abstract submitted for review in violation of the deadline is evaluated with a decrease in the number of weight points.

### Violation of deadlines and incentive points

Encouragement points		Penalty points *	
Criterion	Weight points	Criterion	Weight points
Improving practical work	1 points (for each practical work)	Untimely implementation and test of practical work	From -0.5 points to -5 points (depending on the delivery date)
Passing distance courses on topics that are agreed with teachers	5 points	Untimely execution and test of calculation and graphic work	From -2 points to -20 points (depending on the construction period)
Registration of scientific work for participation in the competition of student scientific works	10 points		
Writing abstracts, articles, participation in international, national and / or other events or competitions on the subject of the discipline	5 points		

\* if the control measure was missed for a good reason (illness, which is confirmed by a certificate of the established sample) - penalty points are not accrued.

### Academic integrity

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

### Norms of ethical behavior

Normative principles of behavior of students and employees, defined in sections 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: <https://kpi.ua/code>.

### **Procedure for appealing the results of control measures**

Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures.

The student has the right to appeal the results of the control measure according to the approved provision on appeals in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (approved by the order №NON/128/2021 from 20.05.2021)-  
<https://osvita.kpi.ua/index.php/node/182>

### **Inclusive education**

The course " Engineering and computer graphics " can be taught to most students with special educational needs, except for students with severe visual impairments who do not allow to perform tasks using personal computers, laptops and / or other technical means.

### **Distance learning**

Distance learning takes place through the Sikorsky Distance learning Platform «Sikorsky».

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Performance of practical works, and also performance of settlement and graphic work, is carried out during independent work of students in a remote mode (with a possibility of consultation with the teacher through e-mail, social networks).

### **Learning a foreign language**

Teaching in English is carried out only for foreign students.

At the request of students, it is allowed to study the material with the help of English-language online courses on topics that correspond to the topics of specific classes.

## **8. Monitor and evaluate the system of evaluation of learning outcomes (Rating System of Evaluation)**

### **Evaluation system (current control):**

No s/n	Control measure	%	Weight points	Number	Total
1.	Express control works / test tasks	21	1,5	14	21
2.	Execution and protection of practical works	21	3	7	21
3.	Modular control work	8	8	1	8
4.	Abstract	10	10	1	10
5.	Exam	40	40	1	40
				<b>Total</b>	100

**Calendar control (CC)** - is performed twice a semester as monitoring of the current state of compliance with syllabus requirements.

The purpose of calendar control is to improve the quality of student learning and monitor the implementation of the schedule of the educational process by students.

Criterion		The first CC	The second CC	
Deadline of calendar controls		8th week	14th week	
Conditions for obtaining a positive result from the calendar control	Current rating		≥ 24 points	≥ 40points
	Execution practical work	PW №№1-4	+	+
		PW №№5-7	-	+
	Express control works / test tasks	At least 4 of any lectures	+	-
		At least 10 of any lectures	-	+
	Modular control work	Estimated MCW	-	+
Abstract	Evaluation of the abstract	-	-	

In case of detection of academic poor quality during training - the control measure is not credited.

### Semester certification of students

Mandatory condition for admission to the exam		Крүмепіў
1	Current rating	RD ≥ 30
2	Obtaining a positive assessment for the performed calculation and graphic work	More than 6 points
3	All practical works are tested	More than 6 points
4	Writing at least 6 express tests / tests	More than 6 points

The results are announced to each student separately in the presence or remotely (by e-mail). Also recorded in the system "Electronic Campus".

Mandatory conditions for admission to the exam:

1. Activity in practical classes.
2. Positive result of the first attestation and the second attestation.
3. Attending lectures.

Table of translation of rating points to grades on a university scale:

Number points	Assessment on the university scale
100-95	Perfectly
94-85	Very good
84-75	Good
74-65	Satisfactorily
64-60	Enough
Less 60	Unsatisfactorily
Admission conditions are not met	Not allowed

The exam is held orally.

## **9. Additional information on the discipline (educational component)**

*The list of questions for preparation for modular control work, and also for preparation for examination is given in appendix 1.*

*Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.*

*The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).*

*The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).*

### **Work program of the discipline (syllabus):**

**Compiled by** Associate Professor of Biomedical Engineering, PhD of Technical Sciences, Dubko Andrii Grigorovich.

**Approved by** the Department of Biomedical Engineering (protocol № 16 of June 21, 2024)

**Approved by** the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 9 of June 26, 2024)

*The list of questions for preparation for modular control work,  
as well as to prepare for the exam*

1. *Why the engineering drawing is called the language of engineers?*
2. *Name different types of drawing instruments.*
3. *What are the standard sizes of drawing boards which are used in engineering practice?*
4. *How will you set the mini drafter? Also explain its functions.*
5. *What are the ways of sharpening a pencil and which type of pencil is suitable for drawing work?*
6. *How will you keep your drawing neat and clean?*
7. *Why cello tape is used instead of drawing pins?*
8. *Why the layout of drawing sheet is necessary?*
9. *List out the contents of title block and its importance.*
10. *Explain the methods of folding a drawing sheet.*
11. *What are the various types of lines used in engineering drawing?*
12. *What do you understand by thickness of lines?*
13. *Define a section line with the help of neat sketch.*
14. *Where and why a cutting plane line is used in a drawing?*
15. *What is necessity of conventional breaks in engineering drawing?*
16. *What are the main requirements of lettering in drawing?*
17. *What do you mean by normal, compressed and extended lettering?*
18. *What are the different styles of letters used in drawing?*
19. *What do you understand by single stroke letters?*
20. *What do you understand by freehand lettering?*
21. *What is the importance of dimensioning?*
22. *Explain the rules of spacing between the letters.*
23. *What is the difference between aligned system and unidirectional system of dimensioning?*
24. *Explain the general rules of dimensioning in drawing.*
25. *What is the importance and the uses of dimensioning and tolerances symbols?*
26. *What is meant by scale in drawing and its applications?*
27. *What are the different types of scales?*
28. *Name the various types of principal of planes of projection.*
29. *Define the terms point, line, plane and solid.*
30. *How are the projection of a point marked from its front view and top view?*
31. *Define the trace of line. What are the various types of trace of a line?*
32. *What is an auxiliary plane?*
33. *What is the importance of sectional views in engineering drawing?*
34. *What do you understand by cutting plane line?*
35. *What are the different types of sections?*
36. *What do you mean by axonometric projection and also specify its various types?*
37. *Differentiate between isometric view and isometric projection.*
38. *Explain the method for making and isometric scale.*
39. *Explain in detail the procedure of draw an isometric view or projection by box method.*
40. *What do you understand by a screw thread? Explain with a neat sketch.*
41. *Define the terms used in screw threads, major diameter, pitch diameter and threaded angle.*
42. *With the help of neat sketch explain the difference between left hand and right hand threads.*
43. *Draw the different types of rivet heads.*

44. *What do you understand by caulking and fullering?*
45. *Describe the way in which a riveted joint may fail and also mention the steps should be taken to prevent the failure.*
46. *What do you mean by butt joint? Explain with the help of neat sketch.*
47. *What do you understand by welding?*
48. *Explain fusion welding.*
49. *What are the different types of welding joints?*