Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Biomedical Engineering

[BMF09] Computer-aided design systems

Syllabus of the academic discipline (Syllabus)

Academic discipline requirements	
Level of higher education	First (bachelor's)
Discipline	16 - Chemical Engineering and Bioengineering
Specialty	163 - Biomedical Engineering
Educational program	All EP
Discipline status	Selective (F-catalog)
Form of obtaining higher education	Full-time
Year of training, semester	Available for selection starting from the 3rd year, fall semester
Scope of the discipline	120 hours, 4 credits. (Lecture 26 hours, Practical 28 hours, Laboratory hours, SRS. 66 hours)
Semester control/control measures	Test
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian / English
Information about the course leader/teachers	Lecturer: Lebedev O. V., Practical: Dubko A. G., SRS: Lebedev O. V.
Course placement	
Academic discipline program	

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

The main goal of the academic discipline "Automated Design Systems" is to develop in students the ability to solve specialized tasks and practical problems of automated design of medical device assemblies and information and measuring medical systems, which involves the use of software and hardware tools for designing mechanical assemblies of medical devices and systems based on two- and three-dimensional automated design and drawing systems. The academic discipline "Automated Design Systems" studies the

use of computer tools for automated design and drawing, software tools for creating libraries of geometric elements of medical device assemblies for automated design systems. The following skills are required to study the discipline:

1. Technical tools for automated design (AutoCAD or FreeCAD environment);

2. Software tools for creating libraries of geometric elements (macros in C++, Python);

3. Analysis of mechanical assemblies of medical devices using the finite element method (FEM).

General competencies (OP put into effect by the Rector's Order NON/89/2021 dated April 19, 2021):

GC 1 - Ability to apply knowledge in practical situations.

GC 4 - Skills in using information and communication technologies.

GC 5 - Ability to conduct research at the appropriate level.

GC 8 - Ability to make informed decisions.

GC 11 - Ability to evaluate and ensure the quality of work performed.

Special (professional) competencies (OP put into effect by the Rector's Order NON/89/2021 dated 04/19/2021):

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

FC 3 - Ability to study and apply new methods and tools for analysis, modeling, design and optimization of medical devices and systems.

FC 6 - Ability to effectively use tools and methods for analysis, design, calculation and testing in the development of biomedical products and services.

FC 10 - Ability to apply the principles of building modern automated medical device production management systems, their technical, algorithmic, information and software support to solve professional tasks.

FC 14 - Ability to conduct experiments according to specified technical and medical methods, perform computer processing, analysis and synthesis of the results obtained.

The program learning outcomes after studying the elective discipline "Automated Design Systems" are (the OP was put into effect by the Rector's Order NON/89/2021 dated 04/19/2021):

PRN 2 - Possession of engineering methods for calculating elements of medical devices and systems and the selection of classical and modern structural materials.

PRN 5 - Knowledge of research methods and techniques used in the design of medical equipment.

PRN 16 - Application of modern programming technologies and tools that support their use.

PRN 25 - Formulation of logical conclusions and substantiation of recommendations for the assessment, operation and implementation of biotechnical, medical-technical and bioengineering tools and methods.

PRN 31 - Understanding of theoretical and practical approaches to the creation and management of medical equipment and medical technology.

PRN 38 - Ability to formulate tasks for the development of automated control systems taking into account the capabilities of modern technical and software tools for the automation of medical equipment.

PRN 40 - Use of automated design systems for the development of technological and hardware schemes of medical devices and systems.

PRN 45 - Improvement of technical elements of medical devices and systems and medical products in the process of professional activity.

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of study according to the relevant educational program)

The academic discipline "Computer Aided Design Systems" belongs to the cycle of professional training and is interdisciplinary in nature. It integrates, in accordance with its subject, knowledge from other academic disciplines: engineering and computer graphics, object-oriented programming, etc. According to the structural and logical scheme of the bachelor's program, the discipline is closely related to other disciplines of general and professional training: "Physics", "Analytical Geometry", "Engineering and Computer Graphics", "Fundamentals of Informatics", "Materials Science and Structural Materials". The practical skills and theoretical knowledge acquired while studying the academic discipline "Automated Design Systems" can be used in the subsequent study of elective academic disciplines: "Biomedical Devices, Apparatus and Complexes", "Expertise and Engineering Support of Medical Equipment", "Fundamentals of Design and Engineering of Medical Equipment".

3. Content of the academic discipline

The main sections and topics that will be covered during the course:
Section 1. Fundamentals of automation of design of medical device and system components.

Topic 1.1. Methodology of automated design.

Topic 1.2. Stages of CAD development and design tools.

Section 2. Automated design of medical device and system components.

Topic 2.1. Automation of design of mechanical components of medical devices and systems.

Topic 2.2. Automation of design of information and measuring systems for medical purposes.

Section 3. Interface, capabilities and settings of the FreeCAD system.

Topic 3.1. General characteristics of the automated design system.

Topic 3.2. Working with layers. Object snapping and tracking modes.

Section 4. Construction, editing and properties of drawing objects.

Topic 4.1. Drawing and editing text, tables and hatching.

Topic 4.2. Drawing and editing dimensions. Drawing templates.

Chapter 5. Creating and using blocks.

Topic 5.1. Working with raster images of objects.

Topic 5.2. Printing drawings. Exchanging information with other CAD systems.

Chapter 6. Basics of working in three-dimensional space.

Topic 6.1. Creating simple spatial primitives.

Topic 6.2. Editing spatial objects.

Chapter 7. Wireframe and surface models.

Topic 7.1. Two- and three-dimensional wireframe and surface models.

Topic 7.2. Model layout. Generating views and sections.

Chapter 8. Creating realistic images of objects.

Topic 8.1. Rendering and creating realistic images.

Topic 8.2. Libraries of geometric elements in C++ and Python.

Chapter 9. Analysis of medical device assemblies using the finite element method (FEM).

Topic 9.1. Static analysis using the finite element method.

Topic 9.2. Dynamic analysis using the finite element method.

Topic 9.3. Nonlinear time-dependent dynamic analysis.

4. Educational materials and resources

Basic literature:

1. Yorik van Havre. A FreeCAD Manual. 2016. – 181 p.

2. Richard Bibb, Dominic Eggbeer, Mazher Iqbal Mohammed. Medical Modeling. *The Application of Advanced Design and Additive Manufacturing Techniques in Medicine. Woodhead Publishing, imprint of Elsevier Ltd.* 2024.-882 p. https://doi.org/10.1016/C2019-0-02458-2

3. Sandip Banerjee. Mathematical Modeling Models, Analysis and Applications. Taylor & Francis Group. 2022. – 415p.

4. Jo Hinchliffe. FreeCAD For Makers. Raspberry Pi Press. 2022.- 104 p.

Additional literature:

1. *FreeCad 0.18 learn by doing. Kishore. 2020.- 139 p.*
2. V. K. CHAUDHARY. FreeCAD [Learn Easily & Quickly]. 2002.-196 p.
3. Robert L. Norton. Design of machinery. An Introduction to the Sinthesis and Analysis of mechanisms. McGraw-Hill. 1999. – 824 p.
4. Geoffrey Boothroyd. Assembly Automation and Product Design. Taylor & Francis. 2005. – 531p.

Electronic resources:
1.The FreeCAD forum: http://forum.freecadweb.org

2. The source code of FreeCAD: https://github.com/FreeCAD/FreeCAD
3. The Facebook FreeCAD community: https://www.facebook.com/FreeCAD
4. The Google+ FreeCAD community:
https://plus.google.com/u/0/communities/103183769032333474646
5. The FreeCAD documentation wiki: http://www.freecadweb.org/wiki
6. Translating FreeCAD on crowdin: https://crowdin.com/project/freecad
7. The FreeCAD bug tracker: http://www.freecadweb.org/tracker

Educational content

5. Methodology for mastering the academic discipline (educational component)

№	Topic	Program learning outcomes	Main tasks	
			Control measure	Deadline
1.	Fundamentals of automation of design of medical device assemblies and systems.	PRN 5 PRN 40	Practical work 1, 2 Laboratory work 1	3rd week
2.	Automated design of medical device assemblies and systems.	PRN 2 PRN 40	Practical work 3, 4 Laboratory work 2	4th week
3.	FreeCAD interface, features and system settings.	PRN 16 PRN 38	Practical work 5, 6 Laboratory work 3	Week 5
4.	Construction, editing, and properties of drawing objects.	PRN 16 PRN 31	Practical work 7, 8 Laboratory work 4	Week 6
5.	Creating and using blocks.	PRN 5 PRN 40 PRN 45	Practical work 9, 10 Laboratory work 5	Week 8
6.	Basics of working in three-dimensional space.	PRN 16 PRN 40 PRN 45	Practical work 11, 12 Laboratory work 6	Week 9
7.	Frame and surface models.	PRN 38 PRN 40	Laboratory work 7	Week 10
8.	Creating realistic images of objects.	PRN 25 PRN 45	Laboratory work 8	Week 11
9.	Analysis of medical device assemblies using the finite element method (FEM).	PRN 2 PRN 5 PRN 16	Laboratory work 9	12th week
10.	Modular test work		Practical work 13	Week 13
11.	Calculation and graphic work	PRN 2 PRN 5 PRN 16 PRN 40 PRN 25	Designing and sending work	Week 13-14
12.	Test		Practical work 14	Week 14

6. Student's independent work

One of the main types of semester control during the mastering of the academic discipline "Automated Design Systems" is writing an essay. The essay is performed in accordance with the requirements, within the time specified by the teacher.

The main goal of writing an essay is to solve a practical problem using theoretical material learned in lectures and independently, and practical skills obtained in practical work. A student can write an essay only on a topic agreed with the teacher.

Approximate topics of the essays:

1. Image management. Standard capabilities.

2. "Mechanical" drawing capabilities.

3. Editing. Programming new types of primitives.

4. Designing drawing files.

5. Static and dynamic blocks.

6. Element libraries.

7. Element parameterization.

8. Components.

9. Printing documents.

10. Interface programming.

11. Python macros.

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

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

The total volume of the abstract, depending on the chosen topic, can vary from 20 to 25 pages of the main text (in agreement with the teacher). The volume of the abstract is determined by the student's ability to concisely and at the same time comprehensively disclose the chosen topic.

Mandatory requirement: clear reference to sources of information. All figures, facts, opinions of scientists, quotes, formulas must have references in the form of [2, p. 54] (the first digit means the number of the source in the list of references given at the end of the creative work, and the second digit is the page number in this source). It is advisable to use tables, diagrams, graphs, charts, etc. The list of sources used (at least 10 sources) is drawn up in accordance with current rules. If the information is taken from the Internet, it is necessary, as for ordinary literature, to indicate the author, the title of the article, and then give the address of the site on the Internet.

The essay is evaluated according to the following criteria: logical plan; completeness and depth of disclosure of the topic; reliability of the data obtained; reflection of practical materials; correct formulation of

conclusions and inferences; design; substantiation of the student's own opinion on this issue in the form of a conclusion.

Deadline for submitting an essay for review: 13-14th week of study.

The essay is not checked for plagiarism, but must meet the requirements of academic integrity. If academic dishonesty is detected, the work is canceled and not checked.

Policy and control

7. Academic discipline policy (educational component)

Attending classes

Attendance at lectures is not mandatory. Attendance at practical classes is desirable, as they include writing express control papers/tests, and practical papers are defended.

The assessment system is focused on obtaining points for student activity, as well as completing tasks that can develop practical skills and abilities.

Missed control measures

Missed control measures (defense of practical and laboratory works) must be worked out in the following classes, provided that the task planned for the current class or consultations is completed.

Missed writing of modular control work and express control tests are not worked out.

An essay submitted for verification in violation of the deadline is evaluated with a decrease in the number of weight points.

Violation of task deadlines and incentive points

Incentive points		*Penalty points **	
Criterion	*Weighted score*	*Criterion*	*Weighted score*
Improving practical work	*1 point (for each practical work)*	*Untimely completion and defense of practical and laboratory work*	*From -0.5 points to -5 points (depends on the deadline)*
Taking distance courses on topics agreed upon with teachers	*5 points*	*Late completion and submission of the abstract*	*From -2 points to -20 points (depends on the submission deadline)*
Preparation of a scientific paper for participation in a student scientific paper competition	*10 points*		
Writing theses, articles, participation in international, all-Ukrainian and/or other events or competitions on the topic of the academic discipline	*5 points*		

** If the control measure was missed for a good reason (illness confirmed by a certificate of the established form) - no penalty points are 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". More details: https://kpi.ua/code.

Norms of ethical behavior

The norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More information: https://kpi.ua/code.

Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the procedure of control measures and expect that it will be considered in accordance with predetermined procedures.

The student has the right to appeal the results of the control measure in accordance with the approved regulation On appeals at Igor Sikorsky Kyiv Polytechnic Institute (approved by order No. HOH/128/2021 dated 05/20/2021) - https://osvita.kpi.ua/index.php/node/182

Inclusive learning

The course "Computer Aided Design Systems" can be taught to most students with special educational needs, except for students with severe visual impairments that prevent them from completing tasks using personal computers, laptops, and/or other technical aids.

Distance learning

Distance learning takes place through the Sikorsky Distance Learning Platform.

Distance learning through additional online courses on a specific topic 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 using such courses is allowed, but students must complete all the tasks provided for in the academic discipline.

The list of courses is offered by the teacher after students express their desire (since the bank of available courses is updated almost every month).

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

Practical and laboratory work, as well as writing an essay, is carried out during the independent work of students in remote mode (with the possibility of consulting with the teacher via email, social networks).

Learning in 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 using English-language online courses on topics that correspond to the topics of specific classes.

8. Types of control and rating system for assessing learning outcomes (RSO)

Evaluation system (current control):

№	Control measure	%	Weighted point	Number	Total
1.	Express control work / test tasks	14	2	7	14
2.	Completion and defense of practical work	24	2	12	24
3.	Performing and defending laboratory work	27	3	9	27
4.	Modular test work	15	15	1	15
5.	Abstract	20	20	1	20
6.	Credit work	80	80	1	80
	Total				100

The applicant receives a positive credit score based on the results of work in the semester if he has a final rating for the semester of at least 60 points and has fulfilled the conditions for admission to semester control, which are determined by the RSO.

With applicants who have fulfilled all the conditions for admission to credit and have a rating score of less than 60 points, as well as with those applicants who wish to increase their rating score, at the last scheduled lesson in the discipline in the semester, the teacher conducts semester control in the form of a credit test or interview.

After completing the test, if the score for the test is higher than the rating, the applicant receives a grade based on the results of the test.

If the score for the test is lower than the rating, a "hard" RSO is applied – the applicant's previous rating (with the exception of the scores for the semester individual assignment) is canceled and he receives a grade based on the results of the test. This option forms a responsible attitude of the applicant to making a decision about completing the test, forces him to critically assess the level of his preparation and carefully prepare for the test.

Calendar control *(CC) - is carried out twice a semester as a monitoring of the current status of implementation of syllabus requirements.*

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

Criterion		First C C	Second C C
Calendar control period		8th week	Week 14
Conditions for	Current rating	≥ 24 points	≥ 40 points

obtaining a positive result from calendar control	*Performing practical work*	*PW № 1- 6*	*+*	*+*
		PW № 7-12	*-*	*+*
	Performing laboratory work	*LW № 1- 4*	*+*	*+*
		LW № 5- 9	*-*	*+*
	Express control work / test tasks	*Minimum of 4 of any lectures*	*+*	*-*
		Minimum of 8 of any lectures	*-*	*+*
	Modular test work	*Estimated MTW*	*-*	*+*
	Abstract	*Graded Essay*	*-*	*-*

If academic dishonesty is detected during studies, the test will not be counted.

Semester certification of students

Mandatory condition for admission to the test		*Criterion*
1	*Current rating*	*RD ≥ 42*
2	*Getting a positive grade for an essay*	*More than 8 points*
3	*All practical work is protected*	*More than 14 points*
3	*All laboratory work is protected.*	*More than 14 points*
4	*Writing at least 6 express control papers / test tasks*	*More than 6 points*

The results are announced to each student individually in person or remotely (by e-mail). They are also recorded in the "Electronic Campus" system.

Mandatory conditions for admission to the test:

1. Activity in practical classes.

2. Activity in laboratory classes.

3. Positive result of the first certification and the second certification.

4. Attendance at 50% of lecture classes.

It is taken into account in the total rating together with the RGR grade if the student did not score 60 points for the semester or he wants to improve his grade.

Table of correspondence of rating points to grades on the university scale

Number of points	**Rating**
100-95	Perfectly
94-85	Very good

Number of points	Rating
84-75	Good
74-65	Satisfactorily
64-60	Enough
Менше 60	Unsatisfactorily
Не виконані умови допуску	Not allowed

9. Additional information on the discipline (educational component)

A list of questions for preparing for the module test, as well as for preparing for the exam, is provided in Appendix 1.

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

The list of courses is offered by the teacher after the students express their desire (since the bank of available courses is updated almost every month).

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

Description of the material, technical and information support of the discipline

Study and work programs of the discipline, RSO, textbook (electronic edition), syllabus, online course in Moodle, practical classes, laboratory practicum URL: https://do.ipo.kpi.ua

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The working program of the academic discipline (syllabus):

Compiled by Lebedev O. V.; Dubko A. G.;
Approved by the BMI Department (protocol No. 15 dated 24/06/2025)
Approved by the methodological committee of the faculty/NII (протокол No. 12 dated 30/06/2025)