Syllabus
of the educational component ED

CAD Fundamentals

Course name:	**CAD Fundamentals**
Level of higher education:	**first (bachelor's)**
Course page in Moodle:	*https://dl2022.khadi-kh.com/course/view.php?id=1038*
The amount of the educational component	**3 credits (90 hours)**
Final control form	**test**
Consultations:	**According to schedule**
Name of the department:	**department of automation and computer-integrated technologies**
Teaching language:	**Ukrainian**
Course leader:	**Anzhela Binkovska, PhD, associate professor**
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Brief content of the discipline:

The purpose of the discipline is to form the student's with the basics of scientific and theoretical knowledge and practical skills in the principles of construction and organization of CAD for design and technological purposes, methods of using CAD to solve problems of automation of design and technological design of electronic devices.

Subject: a pedagogically adapted system of concepts about computer-aided design systems and methods of their use for designing modern electronic equipment and automation systems.

The main tasks of the discipline are:

forming in students a set of knowledge, skills and ideas necessary for independent solution of professional problems related to the students' mastering of the principles of application of automated design systems for design and technological purposes, with students learning the basics of computer-aided design theory, with the acquisition of skills related to the design of automated and automatic process control systems.

Prerequisites for studying the discipline:

Computer graphics; Electrical Engineering and Electrical Mechanics; Electronics and Micro-Circuit Engineering; Automation Equipment; Microprocessor Elements and functional units of information and measuring systems

Competencies acquired by the student:

General competencies:

Ability to apply knowledge in practical situations.

Ability to communicate in the state language both orally and in writing.

Skills in the use of information and communication technologies.

Ability to search, process and analyse information from various sources.

Special (professional) competencies:

Ability to justify the choice of technical means of automation based on an understanding of the principles of their operation, analysis of their properties, purpose and technical characteristics, taking into account the requirements for the automation system and operating conditions; to debug technical means of automation and control systems.

Ability to justify the choice of technical structure and be able to develop application software for microprocessor-based control systems based on local automation tools, industrial logic controllers and programmable logic matrices and signal processors.

Ability to design automation systems taking into account the requirements of relevant regulations and international standards.

Learning outcomes according to the educational program:

Understand physics, electrical engineering, electronics and circuitry, microprocessor technology at the level required to solve typical automation tasks and problems.

Understand the essence of the processes occurring in automation objects in the fields of instrumentation and automation of construction, road machinery and equipment, and be able to analyze automation objects and justify the choice of structure, algorithms and control schemes based on the results of studying their properties.

To be able to apply knowledge of the basic principles and methods of measuring physical quantities and basic technological parameters to justify the choice of measuring instruments and evaluate their metrological characteristics.

To be able to know the principles of operation of technical means of automation and be able to justify their choice based on the analysis of their properties, purpose and technical characteristics, taking into account the requirements for the automation system and operating conditions; have the skills to debug technical means of automation and control systems.

To be able to increase the degree of automation and robotization of construction, road machinery and equipment, taking into account the world level of scientific and engineering achievements in the development and operation of automated engineering systems, including the Internet of Things and Industry 4.0 technologies.

Theme plan

Theme No	Name of themes (LEC, PW, SS)	Number of hours	
		full-time	extramural
1	LEC. Basic concepts and definitions. The structure of CAD. Means of providing CAD. Classification	2	2
	PW. Formation of components by means of CAD for design and technological purposes	2	2
	SS. Equirements for radio-electronic equipment and classification of radio-electronic equipment according to operating conditions.	7	7
2	LEC. Principles of building a CAD system	2	2
	PW. Formation of components by means of CAD for design and technological purposes	2	2
	SS. CAD in the design of electrical and radio products. Classification of CAD languages	7	7
3	LEC. The process of developing an electronic device	2	2
	PW. Formation of components by means of CAD for design and technological purposes	2	2
	SS. CAD capabilities, applications and software technologies	7	7
4	LEC. Types and schemes of a typical design route	2	2
	PW. Formation of components by means of CAD for design and technological purposes	2	2
	SS. Design requirements. Quality characteristics	7	7
5	LEC. New technologies and design tools	2	2
	PW. Formation of a graphic representation of an electrical circuit schematic by means of CAD for design and technological purposes	2	2
	SS. Technologies for the production of PCBs. Criteria for selecting the design of PCBs	7	7
6	LEC. The role of CAD in the industrial cycle	2	2

	PW. Formation of a graphic representation of an electrical circuit schematic by means of CAD for design and technological purposes	2	2
	SS. Complex of works on creation of new equipment	8	8
7	LEC. Mathematical support of machine graphics and geometric modeling subsystems	2	2
	PW. Formation of a graphic representation of an electrical circuit schematic by means of CAD for design and technological purposes	2	2
	SS. Stages of the life cycle of industrial products and automated systems at the stages of the life cycle	7	7
8	LEC. Classification, purpose and basic functionality of modern integrated CAD systems (CAD/CAM/CAE- systems)	2	2
	PW. Tracing of printed pcb connections by means of CAD for design and technological purposes	2	2
	SS. Flexible automated production of PCBs	7	7
Total	Lections	16	16
	Practical works	16	16
	Self-study	58	58
Total for course		90	90

Individual educational and research task: not provided.

Teaching methods:
-verbal method (lecture, explanation, story);
- practical method (practical classes);
- visual method (method of illustrations, method of demonstrations, independent observation, drawing up graphic diagrams and tables);
- work with literature (educational and methodical literature; normative literature; work with textbooks and manuals; search for information on the task);
- video method in combination with the latest information technologies and computer-based learning tools (distance, multimedia);
- independent work.

Forms and methods of assessment
- intersession control (current check)
- final control (semester credit)
- practical test (defense of practical works)
- methods of self-control and self-assessment

Evaluation system and requirements:

Current performance
1 The current success of applicants for the performance of educational types of work in training sessions and for the performance of independent work tasks is evaluated using a four-point rating scale with subsequent transfer to a 100-point scale. During the evaluation of the current academic performance, all types of work provided for by the educational program are taken into account.
1.1 Lecture classes are evaluated by determining the quality of performance of specified tasks.
1.2 Practical classes are evaluated by the quality of performance of a control or individual task, performance and design of practical work.
1.3 Laboratory classes are evaluated by the quality of reports on the performance of laboratory work.
1.4 Seminar classes are evaluated by the quality of individual assignment/abstract.

2 The current performance of higher education applicants is assessed at each practical session (laboratory or seminar) on a four-point scale ("5", "4", "Z", "2") and entered in the journal of academic performance.

– "excellent": the winner mastered the theoretical material flawlessly, demonstrates deep knowledge of the relevant topic or academic discipline, the main provisions;

- "good": the applicant has mastered the theoretical material well, has the main aspects from primary sources and recommended literature, presents it in a reasoned way; has practical skills, expresses his thoughts on certain problems, but certain inaccuracies and errors are assumed in the logic of the presentation of theoretical content or in the analysis of practical ones;

- "satisfactory": the applicant has basically mastered the theoretical knowledge of the educational topic or discipline, orients himself in primary sources and recommended literature, but answers unconvincingly, confuses concepts, answers additional questions uncertainly, does not have stable knowledge; when answering questions of a practical nature, reveals inaccuracy in knowledge, does not know how to evaluate facts and phenomena, connect them with the future profession;

– "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, hardly orients himself in primary sources and recommended literature, lacks scientific thinking, practical skills are not formed.

3 The final score for the current activity is recognized as the arithmetic mean sum of points for each lesson, for individual work, current test works according to the formula:

$$K^{current} = \frac{K1 + K2 + ... + Kn}{n},$$

where $K^{current}$ is the final assessment of success based on the results of current control;

$K1, K2, ..., Kn$ – evaluation of the success n of the current control measure;

n - the number of measures of current control.

Assessments are converted into points according to the calculation scale (table 1).

Table 1 – Recalculation of the average grade for the current activity into a multi-point scale

4-point scale	100 points scale	4-ball scale	100 points scale	4-ball scale	100 points scale	4-ball scale	100 points scale
5	100	4.45	89	3.90	78	3.35	67
4.95	99	4.4	88	3.85	77	3.3	66
4.9	98	4.35	87	3.80	76	3.25	65
4.85	97	4.3	86	3.75	75	3.2	64
4.8	96	4.25	85	3.7	74	3.15	63
4.75	95	4.20	84	3.65	73	3.1	62
4.7	94	4.15	83	3.60	72	3.05	61
4.65	93	4.10	82	3.55	71	3	60
4.6	92	4.05	81	3.5	70	from 1.78 to 2.99	from 35 to 59
						reassembly	
4.55	91	4.00	80	3.45	69	from 0 to 1.77	from 0 to 34
4.5	90	3.95	79	3,4	68	repeated study	

Final assessment

1 The exam is held after studying all topics of the discipline and is completed by students of higher education during the examination session after the end of all classroom classes

2 Students of higher education who have completed all types of work prescribed by the curriculum in the discipline are admitted to the exam:

- were present at all classroom classes (lectures, seminars, practical);
- completed all missed classes on time;
- scored the minimum number of points for the current academic performance (at least 36 points, corresponding to the national scale "3");

If the current success in the discipline is lower than 36 points, the higher education applicant has the opportunity to increase his current point to the minimum before the beginning of the examination session.

3 Assessment of the knowledge of applicants when taking the exam is carried out on a 100-point scale.

Assessment of the knowledge of applicants through testing is carried out according to the following scale:

– "Excellent": at least 90% of correct answers;
– "Very good": from 82% to 89% of correct answers;
– "Good": from 74% to 81% of correct answers;
– "Satisfactory": from 67% to 73% of correct answers;
– "Satisfactory enough": from 60% to 66% of correct answers;
– "Unsatisfactory": less than 60% of correct answers.

4 The final grade for the academic discipline is defined as a weighted average grade that takes into account the overall grade for the current academic performance and the grade for passing the exam.

5 The calculation of the overall final grade for the study of an academic discipline is carried out according to the formula:

$$PK^{fin} = 0{,}6 \cdot K^{current} + 0{,}4 \cdot E,$$

where PK^{fin} is the final assessment of success in disciplines, the form of final control for which is an exam;

$K^{current}$ – final assessment of success based on the results of current control (on a 100-point scale);

E - grade based on the results of the exam (on a 100-point scale).

0.6 and 0.4 are coefficients for the ratio of points for current success and passing the exam.

6 For performing individual independent work and participation in scientific events, additional points are awarded to the winners.

6.1 Additional points are added to the sum of points scored by the student of higher education for the current educational activity (for disciplines for which the final form of control is a test), or to the final grade in the discipline for which the final form of control is an exam.

6.2 The number of additional points awarded for different types of individual tasks depends on their volume and importance:

– prizes in the discipline at the international / all-Ukrainian competition of scientific student works - 20 points;
– prize places in the discipline at the all-Ukrainian Olympiads - 20 points;
– participation in the international / all-Ukrainian competition of scientific student works - 15 points
– participation in international / all-Ukrainian scientific conferences of students and young scientists - 12 points;
– participation in all-Ukrainian Olympiads in the discipline - 10 points

– participation in olympiads and scientific conferences of the KhNAHU in the discipline - 5 points;

- performance of individual scientific and research (educational and research) tasks of increased complexity - 5 points.

6.3 The number of additional points cannot exceed 20 points.

7 The total final grade for studying an academic discipline cannot exceed 100 points.

The overall final grade for the study of the academic discipline is determined according to the scale given in Table 2.

Table 2 – The scale for evaluating the knowledge of the students based on the results of the final control of the academic discipline

Score in points	Evaluation on a national scale		ECTS scale	
			Rating	Criteria
	examination	test		
90-100	**Perfectly**	**Passed**	**A**	The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have been formed, all educational tasks provided for in the training program have been completed, the quality of their performance has been assessed with a number of points close to the maximum
80–89	**Good**	**Passed**	**B**	The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have mainly been formed, all educational tasks provided for by the training program have been completed, the quality of most of them has been assessed with a number of points close to the maximum
75-79			**WITH**	The theoretical content of the course has been mastered in its entirety, without gaps, some practical skills of working with the mastered material have not been formed enough, all educational tasks provided for by the training program have been completed, the quality of none of them has been assessed with a minimum number of points, some types of tasks have been completed with errors
67-74	**Satisfactorily**		**D**	The theoretical content of the course is partially mastered, but the gaps are not of a significant nature, the necessary practical skills for working with the mastered material are basically formed, most of the educational tasks provided by the training program have been completed, some of the completed tasks may contain errors

Score in points	Evaluation on a national scale		ECTS scale	
			Rating	Criteria
	examination	test		
60–66			**E**	The theoretical content of the course has been partially mastered, some practical work skills have not been formed, many educational tasks provided by the training program have not been completed, or the quality of some of them has been assessed with a number of points close to the minimum.
35–59	**Unsatisfactorily**	**Not passed**	**FX**	The theoretical content of the course has been partially mastered, the necessary practical work skills have not been formed, most of the prescribed training programs of educational tasks have not been completed, or the quality of their implementation has been assessed with a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the performance of educational tasks (with the possibility of retaking)
0–34	**Unacceptable**		**F**	The theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all completed educational tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the performance of educational tasks (with a mandatory repeat course)

Course policy:

– the course involves working in a team, the environment in the classroom is friendly, creative, open to constructive criticism;

- mastering the discipline involves mandatory attendance of lectures and practical classes, as well as independent work;

- independent work involves the study of individual topics of the academic discipline, which are presented in accordance with the program for independent study, or were considered briefly;

– all tasks provided by the program must be completed within the set time;

- if the student of higher education is absent from classes for a good reason, he presents the completed tasks during independent preparation and consultation of the teacher;

- the coursework must be protected no later than a week before the beginning of the examination session;

- while studying the course, students of higher education must comply with the rules of academic integrity set forth in the following documents: "Rules of academic integrity of participants in the educational process of the KhNAHU" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.pdf), "Academic integrity. Checking the text of academic, scientific and qualification papers for plagiarism" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_85_1_01.pdf),

"Moral and ethical code of participants in the educational process of the KhNAHU (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf).
- in case of detection of plagiarism, the applicant receives 0 points for the task and must repeat the tasks provided for in the syllabus;
- writing off during tests and exams is prohibited (including using mobile devices). Mobile devices are allowed to be used only during online testing.

Recommended Books:

1. Petrenko A.I. Fundamentals of design automation - K.: Technology 1982. - 295 p.
2. Nevliudov S.I., Berezhna M.A. Computer technologies of automated production: Study guide - Kharkiv: LLC "Company SMIT", 2007. - 368 p.
3. Miroshnyk M.A. Automation systems for designing devices and automation systems: Lecture notes. - Kharkiv: UkrDAZT, 2013. - 80 p.
4. Paerand Y.E. Fundamentals of design and reliability of electronic devices: Study guide. - Alchevsk: DSTU, 2008. - 155 p.
5. A.F. Babicheva, S.M. Esaulov Automated design of electromechanical devices, components of digital control systems and diagnostic complexes: a textbook; Kharkiv National University of Municipal Economy named after A.M. Beketov - Kharkiv: KhNUMH named after A.M. Beketov, 2018. 355 p.
6. Zinko R.V., Topilnytskyi V.G. 3D modeling systems: a textbook. Lviv: Galician Publishing Union, 2017. - 150 p.
7. Karatanov A. V. Methods and models for assessing the quality of computer-aided design systems in a single information space // Control, navigation and communication systems. 2013. 3(27). c.122- 128.
8. DSTU 3321_2003 System of design documentation. Terms and definitions of basic concepts. Published by the official. Kyiv: Gosstandart of Ukraine, 2005. 51 c.
9. DSTU 2226-93. Automated systems. Terms and definitions. Published by the official. Kyiv: Gosstandart of Ukraine, 1994. 93 c. URL: http://online.budstandart.com/ua/catalog/doc-page.html?id_doc=61937.
10. Pedagopu, V. M., M. Kumar Adejuyigbe Integration of CAD/CAPP/CAM/CNC to Augment the Efficiency of CIM. International Review of Applied Engineering Research. – 2014. – Vol. 4. – P. 171–176.
11. Korpyljov, D. The structure of web-oriented cad system for microelectronic devices of designing / D. Korpyljov, S. Tkachenko // Вісник Національного університету «Львівська політехніка». Комп'ютерні системи проектування. Теорія і практика. – 2013. – № 777. – С. 61–65.
12. Kohlhase, M. Knowledge management for systematic engineering design in CAD systems. Professionelles Wissenmanagement. – 2013. – Vol. 7. – P. 202–217.

Additional sources:

1. distance learning course: *https://dl2022.khadi-kh.com/course/view.php?id=1038*
2. How CAD Has Evolved Since 1982. URL: https://www.scan2cad.com/blog/cad/cad-evolved-since-1982/.
3. Vernadsky National Library. URL: http://www.nbuv.gov.ua/.
4. The history of computer-aided design and computer-aided manufacturing (CAD/CAM). URL: https://technicalfoamservices.co.uk/blog/blog-history-of-cad-cam/ .
3 CAD software in mechanical engineering. URL: http://www.znannya.org/?view=CAD_mech.

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