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

Department of Automation
of Electrical and
Mechatronic Complexes

AUTOMATED DESIGN SYSTEMS
ELECTROMECHANICAL SYSTEMS AND COMPLEXES

Syllabus of the academic discipline (Syllabus)

Academic discipline requirements

Level of higher education ***Second (Master's)*** **Field of knowledge**	*G – Engineering, Manufacturing and Construction*
Specialty	*G3 – Electrical Engineering*
Educational program	*Engineering of intelligent electrical and mechatronic complexes*
Discipline status Form of study Year of preparation, semester	*Regulatory* *face-to-face/ distance/ blended* *First fall semester*
Scope of the discipline	*5 ESTC credits (120 hours: 30 hours - lectures, 16 hours - computer workshops, 74 hours - CTS)*
Semester control/tests events	*Test*
Class schedule	*roz.kpi.ua*
Language of instruction	*Ukrainian*
Information about the course leader/teachers	Lecturer: *Candidate of Technical Sciences, Associate Professor Listovshchyk Leonid , listovshchyk.leonid@lll.kpi.ua* Computer workshops: *Candidate of Technical Sciences, Associate Professor Listovshchyk Leonid, listovshchyk.leonid@lll.kpi.ua*
Course placement	*Google classroom: wimltvm*

Academic discipline program

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

The discipline lays the foundation for the study of other disciplines: "Technical Risks", "Engineering of Electrical and Mechatronic Systems" and similar ones, which provide for the use of computer-aided design systems for the simulation study of systems, complexes and processes in electromechanics. ***The purpose*** *of studying the discipline is to form in students*

the ability to solve applied problems in the study of existing and design of new elements and means of electromechanical systems and complexes.

The subject *of study of the discipline is electromechanical systems and complexes, their arrangement, features of functioning, rational set of machines and mechanisms depending on the method of their use. The study of these issues is based on technical mechanics, hydraulics and hydropneumatic drives, physics. Related disciplines are: "Intelligent decision-making systems", "Reliability of electrical and mechatronic systems". As a result of studying the discipline "Systems of automated design of electromechanical systems and complexes", students receive the following* ***professional competencies:***

1) the ability to apply existing and develop new methods, techniques, technologies and procedures to solve engineering problems in electric power engineering, electrical engineering and electromechanics (FK01);

2) the ability to use software for computer modeling, computer-aided design, computer-aided manufacturing, and computer-aided development or construction of elements of electrical power, electrical engineering, and electromechanical systems (FK09);

3) Ability to calculate and develop optimal equipment designs and operating modes of simple and complex electromechanical complexes using modern computer methods of mathematical modeling based on the analysis of static and dynamic loads and operating characteristics (FC14).

and ***program learning outcomes:***

1) Reproduce processes in electrical power, electrical engineering and electromechanical systems during their computer modeling (PRN01);

2). Master new versions or new software designed for computer modeling of objects and processes in electrical power, electrical engineering and electromechanical systems (PRN14);

3) Perform physical and mathematical modeling, static and dynamic analysis of structures, mechanisms, materials and processes at the design stage, investigate the reliability of systems using modern computer tools (PRN15).

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

The study of the discipline is based on technical mechanics, hydraulics and hydropneumatic drives, physics. Related disciplines are: "Intelligent decision-making systems", "Reliability of electrical and mechatronic systems". As a result of studying the discipline "Systems of automated design of electromechanical systems and complexes".

3. Content of the academic discipline

1. Topic 1.1 General information about design.
2. Topic 1.2 Using CAD Types. 3. Topic 1.3 CAD Components. Basic Types of Information in CAD
4. Topic 1.4 CAD components. Representation of objects in CAD 5. Topic 1.5 Methods for calculating the stress state of structures used in CAD.
6. Topic 1.6 Calculation of the stress-strain state of a structure using the finite element method elements.
7. Topic 1.7 Evaluation and optimization of design technological solutions 8. Topic 1.8 Rapid prototyping and manufacturing
9. Topic 1.9 Virtual Engineering

4. Educational materials and resources

Basic literature

1. Kozyar M.M., Feshchuk Y.V., Parfenyuk O.V. Computer graphics: SolidWorks: textbook, Y.V. Feshchuk, O.V. Parfenyuk. - Kherson: Oldi-plus, 2018. – 252
2. Design of elements of mechatronic systems in the SolidWorks environment [Text]: methodical instructions for the implementation of a computer workshop for students of the direction of training 6.050702 "Electrical Mechanics" / Compiled by: L.K. Listovshchyk, V.O. Polishchuk, M.P. Kalyush. – Kyiv: NTUU "KPI", 2013. - 76 p.
3. Tickoo S. SolidWorks 2017 for Designers / S. Tickoo // CADCIM Technologies, 2017. - 2223 p.
4. Listovshchik L.K. Fundamentals of geometric modeling in SolidWorks. Part 1: textbook/ L.K. Listovshchyk. – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 69 p.

Additional literature

5. Methodological instructions for conducting computer workshops in the discipline “Application software packages for designing electrical machines”, use of systems

automated design AutoCAD and SolidWorks for the design of electrical machines / Compiled by: Yu.M. Vaskovsky, Yu.A. Gaidenko, S.S. Tsyvinsky. – Kyiv: NTUU “KPI NAMED AFTER I.SIKORSKHO”

6. Methodological instructions for performing practical work in the discipline “Fundamentals of Design and CAD” for the preparation of bachelors in the direction 6.050502 “Engineering Mechanics”, 6.050503 “Mechanical Engineering” / compiled by: G.I. Tantsura – Dneprodzerzhinsk, DSTU, 2011 – 80 p.

7. Modern technologies for designing REA. Methodological instructions for performing laboratory work for students of specialty 172 "Telecommunications and Radio Engineering" of all forms of study. –

Chernihiv: Chernihiv National Technical University, 2019. – 67 p.

8. Methodological instructions for performing laboratory work on the discipline of CAD/CAM systems for students of specialty 151 "Automation and computer-integrated technologies" / Compiled by: V.G. Makshantsev - Kramatorsk: DSMA. 2018.-57 p.

9. Kholodnyak Yu. V. Computer-aided design of industrial products: a teaching and methodological manual for performing practical work / Yu. V. Kholodnyak; TSATU. – Melitopol: TSATU, 2020. – 152 p.

10. Bethune JD Engineering Design and Graphics with SolidWorks 2016 / JD Bethune // Peachpit Press, 2016. - 784 p.

11. Onwubolu GC Introduction to SolidWorks: A Comprehensive Guide with Applications in 3D Printing / GC Onwubolu // CRC Press, 2017. - 1193

12. Tickoo S. SolidWorks 2017 for Designers / S. Tickoo // CADCIM Technologies, 2017. - 2223 p.

13. Verma G. SolidWorks 2017 Black Book / G. Verma, M. Weber // CADCAMCAE Works, 2017. - 518 p.

14. Dassault System SolisWorks website. http://www.solidworks.com.

Information resources

1. https://classroom.google.com/c/MTU5MjI2NDY3Nzcw?cjc=wimltvm
2. https://aemk.kpi.ua

Educational content

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

Training sessions are implemented in the form of lectures, computer workshops, individual lessons, including using distance learning technologies (Google Classroom, Zoom conferences, etc.).

Names of content modules and topics	*Number of hours*			
	Total	*including*		
		Lectures	*Computer workshops*	*CRC*
1	*2*	*3*	*4*	*5*
Lecture 1. General information about design. Basic definitions, types of design. Purpose of creating CAD. CAD systems used in the world.	*6*	*2*		*5*
Lecture 2 CAD as part of CALS - technologies. System-wide principles of CAD.	*9*	*3*	*2*	*5*
Lecture 3. Stages of CAD creation. Types of CAD support.	*8*	*2*	*2*	*5*
Lecture 4. Using CAD, CAM, and CAE in product development and production.	*8*	*2*	*2*	*5*
Lecture 5. Using CAD in the product life cycle.	*8*	*2*	*2*	*5*

Lecture 6. CAD components. Basic types of information in CAD	7	3		5
Lecture 7. Hardware. Representation of graphic information on a computer. Main types of graphic information.	8	3	2	5
Lecture 8. Requirements for CAD information support. Automated information systems.	7	2	2	5
Lecture 9. Data banks and information retrieval systems, forms of data organization.	5	2		5
Lecture 10. Methods of calculating the stress state of structures used in CAD. Methods of resistance of materials and structural mechanics.	4	1		5
Lecture 11. Numerical methods Calculation of the stress state of a structure. Classification of calculations.	4	1		5
Lecture 12. Calculation of stress - deformed state of the structure using the finite element method.	5	1	1	5
Lecture 13. Basic terminology, notation and definition of the finite element method. Stages of practical implementation of the method finite elements. Approximation of the original elements.	5	1	1	5
Lecture 14. Evaluation and optimization of project technological solutions. Basic technical and economic parameters.	4	1		5
Lecture 15. Criteria for the development of technical objects. Optimization of technical solutions. Concept of decision-making	4	1		5
Lecture 16. Rapid prototyping and manufacturing. Rapid prototyping and manufacturing processes. Solid-state hardening.	5	1	1	5
Lecture 17. Three-dimensional printing. Laser sintering. Lamination. Other prototyping methods.	5	1	1	5
Lecture 18. Virtual Engineering	8	3	2	5
MKR based on the material covered	6	4		2
Exam	4			4
Total hours	1 2 0	3 0	1 6	74

Lecture classes

No. s/p	Title of the lecture topic and list of main questions
1	Lecture 1. General information about design. Basic definitions, types of design. The purpose of creating CAD. CAD systems used in the world. Recommended literature: [1, 3]
2	Lecture 2. CAD as part of CALS technologies. System-wide principles of CAD. Recommended reading: [1, 10, 11]
3	Lecture 3. Stages of CAD creation. Types of CAD support. Recommended reading: [1, 8, 14]
4	Lecture 4. Using CAD, CAM and CAE in development and production product. Recommended reading: [3]
5	Lecture 5. Using CAD in the product life cycle. Recommended reading: [7, 11]
6	Lecture 6. CAD components. Basic types of information in CAD Recommended reading: [1, 6]
7	Lecture 7. Hardware. Representation of graphic information on Computer. Main types of graphic information. Recommended reading: [1, 5]
8	Lecture 8. Requirements for CAD information support. Automated information systems. Recommended reading: [5]
9	Lecture 9. Data banks and information retrieval systems, forms of organization data. Recommended reading: [4]
10	Lecture 10. Methods of calculating the stress state of structures used in CAD. Methods of resistance of materials and structural mechanics. Recommended reading: [7,10]
11	Lecture 11. Numerical methods for calculating the stress state of a structure. Classification of calculations. Recommended reading: [10]
12	Lecture 12. Calculation of the stress-strain state of a structure using the finite element method. Recommended reading: [12]
13	Lecture 13. Basic terminology, notation and definition of the finite element method. Stages of practical implementation of the finite element method. Approximation of initial elements. Recommended literature: [13]
14	Lecture 14. Evaluation and optimization of project technological solutions. Main technical and economic parameters. Recommended literature: [11, 13]
15	Lecture 16. Criteria for the development of technical facilities. Optimization of technical Decision making concept Recommended reading: [12, 13]
16	Lecture 17. Rapid prototyping and manufacturing. Rapid prototyping and manufacturing processes. Solid-state hardening. Recommended reading: [13]
17	Lecture 18. Three-dimensional printing. Laser sintering. Lamination. Other methods Prototyping. Recommended reading: [13]
18	Lecture 19. Virtual Engineering Recommended reading: [9]

Computer workshops

The main tasks of the cycle of computer workshops are devoted to the formation of competencies in the geometric design of electromechanical system objects and the use of CAD to determine the main characteristics of these objects.

No. s/	Title of the lesson topic and list of main questions
n 1	***Study of the part model using Simulation Xpress*** *Didactic tools: methodological instructions that allow you to form input data for execution and explain the progress of the work. Recommended literature:* *[1 - 4]* *VTS: Performing tasks according to options on a given topic.*
2	***Studying assembly elements using SolidWorks Simulation.*** *Didactic tools: methodological instructions that allow you to form input data for execution and explain the progress of the work. Recommended literature:* *[1 - 4]* *VTS: Performing tasks according to options on a given topic.*
3	***Study of processes in elements of a hydraulic system using FlowWorks module*** *Didactic tools: methodological instructions that allow you to form input data for execution and explain the progress of the work. Recommended literature:* *[1 - 4]* *VTS: Performing tasks according to options on a given topic.*
4	***Study of the kinematics of the executive body using the SolidWorks Motion module*** *Didactic tools: methodological instructions that allow you to form input data for execution and explain the progress of the work. Recommended literature:* *[1 - 4]* *VTS: Performing tasks according to options on a given topic.*
5	***Thermal analysis*** *Didactic tools: methodological instructions that allow you to form input data for execution and explain the progress of the work. Recommended literature:* *[1 - 4]* *VTS: Performing tasks according to options on a given topic.*

6. Student independent work

Independent student work involves:
preparation for classroom lessons – 74 hours;
preparation for the modular test – 2 hours;
exam preparation – 4 hours.

Policy and control

7. Academic discipline policy (educational component)

Study of the academic discipline “Computer Aided Design Systems”
"Electromechanical Systems and Complexes" requires from the applicant for higher education:
- compliance with educational and academic ethics;
- adherence to the schedule of the educational
process; - being balanced and attentive in classes;
- systematically study theoretical material;

- compliance with the schedule for defending computer labs. The applicant's response must demonstrate signs of independent performance of the assigned task, the absence of signs of repetition and plagiarism.

If a higher education student was absent from a lecture, he or she should make up the lecture in another time (with another group, in consultation).

If a higher education student was absent from practical classes, he/she should make up the missed work. these classes at a different time (with another group, in consultation).

A student can receive up to 10 additional points if they receive a certificate in the course "Autodesk CAD/ CAM/CAE for Mechanical Engineering" on the Coursera website at: https://www.coursera.org/specializations/ autodesk-cad-cam-cae-mechanical-engineering and the like in agreement with the teacher.

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

Current control:

A student's rating for a credit module consists of the points he receives for: 1) completing and defending 6 computer labs;
2) completion of 1 modular test;
3) performing calculation work.

Rating points system and evaluation criteria:

	timely surrender	1 retake (within two weeks from initial control)	2 retakes (without compliance with deadlines)
1. Completion of modular test work:			
completely correctly completed work 24 work completed with minor errors work not credited	28		20
	24	20	18
	0	0	0
2. Performing computer workshops:			
- the task was defended with excellent mastery of the material -	12	10	8
the task was completed with excellent mastery of the material	10	8	6
- task not completed	0	0	0

According to the results of the educational work for the first 7 weeks, the maximum amount of points scored is 36 points (3 lab. practicals). At the first certification (8th week), the student receives a "pass" if his current rating **is not less than 0.5*36 = 18 points.**

Based on the results of 12 weeks of training, the maximum amount of points scored should be 60 points. (5 lab. practicals). At the second certification (14th week), the student receives a "pass" if his current rating is **at least 0.5*60 = 30 points.**

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

Number of points	*Rating*
100-95	Perfectly
94-85	Very good
84-75	Good
74-65	Satisfactorily
64-60	Enough
Less than 60	Unsatisfactorily
Admission conditions not met	Not allowed

Rc(max)=6x12+1x28=100 points

Rÿ(min)=6ÿ12·0.5+1ÿ28·0.5=50 points

Additional information on the discipline (educational component)

Review questions

1. The concept of "CAD"
2. CAD as part of CALS technologies. System-wide principles of CAD.
3. Stages of CAD creation.
4. Types of CAD software. 5.
Use of CAD, CAM and CAE in product development and production.
6. Using CAD in the product life cycle.
7. CAD components.
8. Basic types of information in CAD.
9. Hardware.
10. Representation of graphic information on a computer. Main types of graphic information.
11. Requirements for information support of CAD. 12.
Automated information systems. 13. Data banks
and information retrieval systems, forms of data organization.
14. Methods of calculating the stress state of structures used in CAD. 15. CAD methods of resistance of materials and structural mechanics. 16. Numerical methods of calculating the stress state of structures.
Classification of calculations.
17. Calculation of the stress-strain state of a structure using the finite element method elements.
18. Basic terminology, notation and definition of the finite element method.
19. Stages of practical implementation of the finite element method. Approximation of the initial elements.
20. Evaluation and optimization of project technological solutions. Main technical and economic parameters.
Criteria for the development of technical objects. Optimization of technical solutions. Concept 21. decision-making

The working program of the academic discipline (syllabus):

Compiled by Candidate of Technical Sciences, Associate Professor Listovshchyk L.K.

Approved by the Department of AEMK (Minutes No. 27 from 23.06.2026)

Approved by the Methodological Council of the NN IEE (minutes No.43 of 29.06.2026)