MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
National Aerospace University
Kharkiv Aviation Institute

Department of Information Technologies of Design (№ 105)

APPROVE

Head EMC 2
D.M. Kritskiy
(підпис) (ініціали та прізвище)

«31» 08 2021 p.

CURRICULUM *SELECTIV*
ACADEMIC DISCIPLINE
Computer-aided Design Systems. Part 2
(назва навчальної дисципліни)

Field of knowledge: "Mathematics and Statistics", "Information Technology", "Automation and Instrumentation", "Chemical and Bioengineering", "Electronics and Telecommunications", "Natural Sciences", "Architecture and Construction"
(шифр і найменування галузі знань)

Specialty: all specialties of the given fields of knowledge
(код і найменування спеціальності)

Educational program: all educational programs of the given fields of knowledge
(найменування освітньої програми)

Form of study: full-time

Level of higher education:
second (master's)

Kharkiv 2021

Curriculum Computer-aided Design Systems. Part 1
(назва дисципліни)

Field of knowledge: "Mathematics and Statistics", "Information Technology", "Automation and Instrumentation", "Chemical and Bioengineering", "Electronics and Telecommunications", "Natural Sciences", "Architecture and Construction"
for students in all specialties of the given fields of knowledge,
according to the educational programs of all educational programs of the given fields of knowledge.
«20» May 2021, – 13 p.

Developer: Kritskiy D.M., head of department information technologies of design, PhD, docent
(прізвище та ініціали, посада, науковий ступінь і вчене звання) (підпис)

The curriculum was considered at the meeting of the Department of Information Technology Design
(назва кафедри)

Protocol № 1 from « 31 » 08 2021 p.

Head of department 105 PhD, docent Kritskiy
(науковий ступінь і вчене звання) (підпис) (ініціали та прізвище)

1. Description of the discipline

<table>
<tr><td>Name of indicators</td><td>Field of knowledge,
training direction,
education level</td><td>Characteristics of the discipline</td></tr>
<tr><td>Number of credits – 3</td><td rowspan="11">Field of knowledge
"Mathematics and Statistics", "Information Technology", "Automation and Instrumentation", "Chemical and Bioengineering", "Electronics and Telecommunications", "Natural Sciences", "Architecture and Construction"
(шифр і найменування)

Specialty
all specialties of the given fields of knowledge
(код і найменування)

Educational program
all educational programs of the given fields of knowledge
(найменування)

Level of higher education:
second (master's)</td><td>Selective</td></tr>
<tr><td>Modules – 2</td><td>Year of preparation:</td></tr>
<tr><td>Content modules – 6</td><td>2021/2022</td></tr>
<tr><td>Individual task not provided</td><td>Semester</td></tr>
<tr><td rowspan="2">The total number of hours – 48 / 90</td><td>2</td></tr>
<tr><td>Lectures *</td></tr>
<tr><td rowspan="2">Weekly hours for full-time study:
classroom – 3
independent work of the student – 2,63</td><td>0</td></tr>
<tr><td>Practical, seminar*</td></tr>
<tr><td>48</td></tr>
<tr><td>Laboratory *</td></tr>
<tr><td>0</td></tr>
<tr><td>Individual work</td></tr>
<tr><td>42</td></tr>
<tr><td>Type of control</td></tr>
<tr><td>modular control,
test</td></tr>
</table>

The ratio of the number of hours of classroom classes to independent work is: *1,14.*

* Classroom load can be reduced or increased by one hour depending on the class schedule.

2. The purpose and objectives of the discipline

The purpose of studying the discipline is to prepare analysts and engineers of computer systems to perform work on the development of integrated automated systems for design and technological purposes.

The main objectives of the discipline are to study the performance of standard subsystems and modules of CAD, standards, methods and tools for system integration and product lifecycle management, the main provisions of the STEP set of standards, technology and organization of design systems.

As a result of studying the discipline the student must

know:

- structure of automated production complexes, role and place in them of automated design and production preparation systems;
- structure of integrated system environments of automated design, functions, quality indicators and selection criteria of functional and service modules;
- requirements for information models of design objects at different stages of development, methods and means of their construction;
- principles of system integration, means of ensuring the interaction of automated systems, the basic requirements of the leading standards for information support of the life cycle (CALS-technology);
- stages of development of automated systems, engineering content and formal tasks of the main tasks of their design.

be able to:

- to determine the characteristics of design processes and the feasibility of creating CAD, to formulate requirements for the functional and information structure of the integrated system of design and preparation of production;
- to develop elements of methodological support of CAD, including methods (technology) of automated design of products and technological processes;
- determine the possibility and feasibility of using ready-made CAD software, determine the requirements for information exchange between them, perform testing and analysis of design and production capabilities;
- assess the compatibility of CAD software, solve problems of complexing software and methodological complexes of CAD and ensuring the interaction of components;
- to master the tools of automation of programming of basic subsystems of CAD and to create specialized design systems.

The student must acquire skills pre-design research, development of the sketch project, and also independent development of ready functional components of systems of designing and realization on their basis of specialized software modules of CAD.
Interdisciplinary links: English**.**

3. The program of the discipline

Module 1. FUNCTIONAL COMPONENTS OF DESIGN SYSTEMS.

Content module 1. The place of CAD among industrial automated systems.

Topic 1. Life cycle automation systems of technical objects. Product life cycle phases. Varieties of industrial automated systems. Purpose and role of design automation systems (CAD), production preparation (ASTPV), process control (ASKTP) and enterprise (ASKP). Needs of integration of automated systems (AS). The concept of CALS-technology.

Topic 2. Approaches to the classification of design systems and CAD components. Prerequisites for creating multi-level design systems. Tools for adapting and expanding the functions of design systems.

Topic 3. Current trends in CAD development. Areas of system engineering activities for the development of automated systems. System integration. Directions, goals and means of AU integration. CASE-tools for creating CAD.

Content module 2. Systems of design and engineering analysis.

Topic 4. Functional indicators of geometric modelers. Classes of geometric modeling systems. Examples of test problems, analysis of results. Development trends of geometric modelers.

Topic 5. Performance indicators of design systems. Specialized modules of design systems: libraries of elements, means of creating electronic catalogs, etc. Comparison criteria and system selection factors.

Topic 6. Characteristics and selection criteria for systems for the synthesis of technical solutions. Autonomous and integrated libraries of general engineering calculations. Nomenclature of objects, capabilities of systems for design calculations and interaction with geometric modelers. Examples of implementation.

Topic 7. Integration of functional and design systems. Ensuring functional interchangeability of products. The procedure for solving problems of functional interchangeability: design calculations, optimization of tolerances, calculation of dimensional chains. Examples of software for dimensional analysis.

Topic 8. Characteristics of mechanism modeling systems. Indicators of functionality of systems of modeling of mechanisms. Directions of integration with CAD-systems. Possibilities of autonomous and integrated systems. System selection criteria.

Topic 9. Characteristics of finite element analysis systems. Typical structure of the finite element analysis system. Functions of preprocessor, processor, postprocessor. Features of analysis problems. Possibilities of universal analysis systems. Directions of integration with CAD-systems. Possibilities of integrated analysis modules.

Topic 10. Trends in the development of finite element analysis systems. with design systems. Multidisciplinarity, areas of efficiency, automation of analysis procedures, advanced modeling. Criteria for selection of analysis systems.

Topic 11. Aerohydrodynamic process analysis systems (CFD systems). Typical problems of analysis of aerohydrodynamic processes. Features of postprocessors and processors of CFD-systems. Capabilities of autonomous systems and integrated CFD modules.

Content module 3. Systems of technological preparation of production.

Topic 12. Integration of design and technological design systems. Ensuring production and operational manufacturability of product design. Manufacturability indicators for parts and assembly units. Possibilities of software to ensure manufacturability.

Topic 13. Technological preparation of production. Information model of the object of production. Methods of describing the object of production (design and technological coding, specialized languages). CAD requirements of technological processes to the information model of the product. Limitations of geometric CAD models in the presentation of technological information.

Topic 14. Characteristics and selection criteria for process design systems. Information model of technological process (TP). Rising data for TP design. Problems of structural and parametric synthesis of TP. Indicators of the functionality of CAD TP (CAPP-systems).

Topic 15. Characteristics and criteria for selecting control systems for automated equipment (CAM-systems). Classification of numerical program control (CNC) systems. Features of construction of technical process of processing on CNC machines: typical schemes (strategies) of processing, standard cycles. Structure and functionality of CAM-systems. CNC modules of integrated systems and autonomous CAM-systems.

Topic 16. Technical means of reversible modeling (3D-scanners). Hardware and software for reproducing the computer model of the product. Examples of implementation.

Topic 17. Technical means of accelerated prototyping (3D-plotters). Physical bases of prototyping methods. Classification and capabilities of prototyping systems.

MODULE 2. METHODS AND MEANS OF SYSTEM INTEGRATION IN THE DEVELOPMENT OF CAD.

Content module 4. Information exchange and project data management

Topic 18. Information integration of design systems. Requirements of associativity of information models. Parallel design. Electronic model, layout and structure of the product. Status of electronic design documents according to the updated ESKD standards.

Topic 19.Data exchange formats between design systems. Exchange in own formats of CAD-systems and in formats of geometric modelers (cores of geometric modeling systems): SAT, XMT_TXT, etc. Standards of data exchange formats. DXF, IGES formats. Types of geometric and graphic objects in IGES. Special STL format. Autonomous and integrated translators. Limitation of standard formats in the representation of parameterized models and non-geometric information. Model structure import tools.

Topic 20. System environments of integrated design systems. Functions and structure of project data management systems (PDM). Features of information support of CAD. Classification of design control systems by scope of functions and hierarchical levels (CPC, PDM, TDM). The main groups of functions of PDM systems. Typical structure of PDM system.

Topic 21. Performance indicators of project data management systems (PDM). Data search methods, modifiability of the data model, configuration management capabilities, interaction with related systems, workflow and document flow management, etc. .

Topic 22. Criteria for selecting design management systems and design data. Additional (non-functional) criteria for comparing PDM systems: system architecture, organization of data storage, possibilities of adaptation, integration with application systems, etc. Trends in the development of PDM systems.

Topic 23. Design Process Control Tools (DesPM). Levels of control of the design process. Functions and structure of DesPM subsystems. Possibilities of automation of synthesis of a design

route. Modeling process control tools in CAE-systems. Examples of systems implementation and prospects for their development.

Topic 24. Product lifecycle management. The needs of automated systems in non-geometric data. Information relationships of CAD with production and operation management systems. Principles of CALS-technology. The concept of PLM solution.

Content module 5. STEP standards as the basis of CALS-technology.

Topic 25. The structure of the set of STEP standards. Application protocols. Implementation of exchange in STEP - exchange files and SDAI databases.

Topic 26. Engineering data exchange tools in STEP. Overview of application protocols STEP AP203, AP214: units of functionality, object classes. Features of STEP-exchange implementation in modern CAD.

Topic 27. Additional standards of CALS-technology. Exchange restrictions in STEP standard formats. Possibilities of STEP standards for the transfer of technological information. STEP AP224 application protocol. Advanced engineering data exchange tools: PLIB, Parametrics, ManDate standards.

Topic 28. Interactive electronic technical documentation. Standards SGML, AECMA Spec 1000D.

Content module 6. Technology and organization of CAD development.

Topic 29. The process of developing design systems. A typical functional diagram of the design of software and hardware CAD. Stages of CAD development. Pre-design studies.

Topic 30. Definition of CAD requirements. Formalized requirements management technologies in SSADM structural technology and object-oriented RUP technology.

Topic 31.CAD project development. Composition and content of CAD design documents.

Topic 32. Criteria of perfection of computer design systems. Approaches to quality assessment of software and methodological complexes of automated systems. Quality indicators of CAD software. Criteria of technical and economic efficiency of ready and independently developed software of design systems.

4. The structure of the discipline

Names of content modules and topics	Number of hours				
	total	including			
		l	p	lab.	i. w.
1	2	3	4	5	6
Module 1. Functional components of design systems					
Content module 1. The place of CAD among industrial automated systems					
Topic 1. Life cycle automation systems of technical objects	3	-	2	-	1
Topic 2. Approaches to the classification of design systems and CAD components	3	-	2	-	1
Topic 3.Current trends in CAD development. CASE-tools for creating CAD.	3	-	2	-	1
Together on the content module 1	9	-	6	-	3
Content module 2. Design and engineering analysis systems					
Topic 4. Functional indicators of geometric modelers	2	-	1	-	1
Topic 5. Functional indicators of design systems	3	-	1	-	2
Topic 6. Characteristics and selection criteria for systems for the synthesis of technical solutions	3	-	1	-	2
Topic 7. Integration of functional and design systems	2	-	1	-	1
Topic 8. Characteristics and selection criteria of mechanism modeling systems	3	-	2	-	1
Topic 9. Characteristics and selection criteria of finite element analysis systems	3	-	2	-	1
Topic 10. Integration of analysis systems with design systems.	4	-	2	-	2
Topic 11. Aerohydrodynamic process analysis systems (CFD systems)	4	-	2	-	2
Together on the content module 2	24	-	12	-	12
Content module 3. Systems of technological preparation of production					
Topic 12. Integration of design and technological design systems	2	-	1	-	1
Topic 13. Technological preparation of production	2	-	1	-	1
Topic 14. Characteristics and selection criteria for process design systems	2	-	1	-	1
Topic 15. Characteristics and criteria for selection of control systems for automated equipment (CAM-systems)	2	-	1	-	1

Topic 16. Technical means of reversible modeling (3D-scanners).	2	-	1	-	1
Topic 17. Technical means of accelerated prototyping (3D-plotters).	2	-	1	-	1
Together on the content module 3	12	-	6	-	6
Total hours for module 1	45	-	24	-	21
Module 2. Methods and tools of system integration in the development of CAD					
Content module 4. Information exchange and project data management					
Topic 18. Information integration of design systems.	2	-	1	-	1
Topic 19. Data exchange formats between design systems	2	-	1	-	1
Topic 20. System environments of integrated design systems.	2	-	1	-	1
Topic 21. Performance indicators of project data management systems (PDM)	2	-	1	-	1
Topic 22. Criteria for selecting design management systems and design data	3		2	-	1
Topic 23. Design Process Control Tools (DesPM)	3	-	2	-	1
Topic 24. Product lifecycle management	3		2	-	1
Together on the content module 4	17		10	-	7
Content module 5. STEP standards as the basis of CALS-technology					
Topic 25. The structure of the set of STEP standards	2	-	1	-	1
Topic 26. Engineering data exchange tools in STEP	2	-	1	-	1
Topic 27. Additional standards of CALS-technology	4	-	2	-	2
Topic 28. Interactive electronic technical documentation	4	-	2	-	2
Together on the content module 5	12	-	6	-	6
Content module 6. Technology and organization of CAD development					
Topic 29. The process of developing design systems	3	-	2	-	2
Topic 30. Definition of CAD requirements	3	-	2	-	2
Topic 31. CAD project development	2	-	2	-	1
Topic 32. Criteria of perfection of computer design systems	2	-	2	-	1
Together on the content module 6	10	-	8	-	6
Total hours for module 2	43	-	24	-	19
control measure	2	-	-	-	2
Total hours for discipline	90	-	48	-	42

5. Topics of seminars

Seminars are not provided in the curriculum.

6. Topics of practical classes

№ s / n	Name topics	Number hours
1.	Setting the task of designing an object. Analysis of requirements for the design system	2
2.	System-wide solutions. Development of design methods	2
3.	Analysis of system structure options. Selection of basic software CAE / CAD / CAM	2
4.	Information conjugation of software	4
5.	Interactive implementation of project procedures	4
6.	Software implementation of the project procedure	4
7.	Testing the interaction of system modules	4
8.	Modular control work № 1.	2
9.	Development of a specialized CAD subsystem by means of a basic CAD system	2
10.	Development of calculation CAD modules by means of universal programming systems	2
11.	Organization of interaction of the application program with the CAD-system	2
12.	Testing the functionality of geometric modeling systems	4
13.	Means of information integration of design systems	2
14.	Analysis of the possibilities of the system of finite element analysis	4
15.	Analysis of capabilities of aerohydrodynamic calculation systems	2
16.	Analysis of the functionality of design management systems and design data	4
17.	Modular control work № 2.	2
	Together	48

7. Topics of laboratory classes

Laboratory classes are not provided in the curriculum

8. Independent work

№ s / n	Name topics	Number hours
1.	Tools for the development of design systems. Development of specialized subsystems for work in the environment of the basic system: specialized programming languages (GRIP, MicroStation Design Language, CADkey Design Language, etc.), versions of universal programming languages (Visual Basic, Visual C ++, MicroStation / JAVA), conjugation with general purpose software . Tools for developing autonomous specialized systems (CAS.CADE). Tools for computerization of engineering knowledge.	6
2.	Development of control programs for machines with numerical program control (CNC). Classification of CNC machines. Manufacturability of the details processed on CNC machines. The order of development of control programs: calculation of coordinates of reference points of a trajectory, coding of programs. The structure of the management program. Frame format. APT input language. CLDATA intermediate language.	6

3.	Special technical means of CAD. Test automation systems, software and hardware automation of engineering document management.	6
4.	IGES standard. Types and parameters of the main objects	6
5.	STEP complex standards. Description methods; implementation methods; integrated shared resources. Types of geometric models and objects. Application protocols STEP AP203, AP214: units of functionality, object classes.	6
6.	Stages and stages of CAD creation. Types and content of CAD design documents. Features of the process of creating systems using accelerated development technologies (RAD).	4
7.	Methods and means of conceptual design of systems. IDEF0 functional analysis methodology. Software tools for functional systems analysis (Design / IDEF, BPWin, etc.). IDEF1X information analysis methodology. Software tools for information analysis and synthesis of systems (ERWin, Model Mart, Meta Base, etc.). Structural technology of SSADM: typical technological process of system design, methodical providing, technique of definition of requirements to system. Object-oriented RUP technology: business modeling, requirements analysis, development of functional system architecture, project management.	4
8.	Current independent work (hours): Work with literature sources and program documentation, work on the synopsis and test tasks, preparation for participation in the CAD Olympiad.	4
	Together	42

9. Individual task

Individual tasks are not provided by the curriculum.

10. Teaching methods

When practice work and independent work, such teaching methods as verbal (explanation, story, conversation, educational discussion, etc.) are used; visual (illustration, demonstration, self-observation) and practical, elements of multimedia course support (video fragments), demonstrations of individual techniques and / or handouts in the form of diagrams and charts.
Practical work is performed using training (demonstration) and licensed software.
Independent work includes preparation for laboratory work, modular control and test, performance outside the classroom of the individual task and the study of the above topics in the abstract, literature sources and program documentation.

11. Control methods

The control is carried out in accordance with the "Regulations on the modular rating system for assessing students' knowledge."

Current control - in accordance with the completeness, quality and timeliness of practical work; intermediate (modular) control - written tests at the 8th and 16th weeks; final control - written test.

12. Evaluation criteria and distribution of points received by students

12.1. Distribution of points received by students (quantitative evaluation criteria)

Components of educational work	Points for one lesson (task)	Number of classes (tasks)	Total number of points
Module 1			
Execution and protection of practical works	0...5	7	0...35
Modular control	0…25	1	0…25
Module 2			
Execution and protection of practical works	0...5	3	0...15
Modular control	0…25	1	0…25
Total for the semester			**0…100**

Semester control (test) is carried out in case of refusal of the student from points of current testing and in the presence of the admission to credit. During the semester test the student has the opportunity to receive a maximum of 100 points.
The ticket for the test consists of 4 questions, each question is evaluated in 25 points, 2 questions are theoretical, 2 questions are practical - the sum of 100 points.

12.2. Qualitative evaluation criteria
The required amount of knowledge to obtain a positive assessment:
- basic concepts, definitions and problems of using CAD systems;
- use of CAD systems for design.
The required amount of skills to obtain a positive assessment:
be able to use CAD systems to design complex systems.

12.3 Criteria for evaluating student work during the semester

Satisfactorily (60-74). Show a minimum of knowledge and skills. Defend all individual tasks and pass the test.

Fine (75-89). Firmly know the minimum, defend all individual tasks, perform all practical tasks, pass testing and out of classroom independent work.

Perfectly (90-100). Pass all checkpoints with a grade of "excellent". Thoroughly know all the topics and be able to apply them.

Grading scale: point and traditional

The sum of points	Score on a traditional scale	
	Exam	Test
90 – 100	Perfectly	Good
75 – 89	Fine	
60 – 74	Satiasfactofily	
0 – 59	Unsatisfactorily	Bad

13. Methodical support

The entire scientific and methodological set of the discipline is posted on the official educational portal of the National Aerospace University "Kharkiv Aviation Institute".

1. Granin V.Yu. Development of computer systems design. Lecture notes (in electronic form). - H., KHAI (Edition Kritskiy D.M. 2020).

14. Recommended Books

Basic

1. Product information model editor. User guide. - M., Center SPRUT-T, 2020.
2. Knowledge base generation system. User guide. - M., Center SPRUT-T, 2020.

Auxiliary

1. Fundamentals of system analysis and design of ACS / Ed. A.A. Pavlova. - K., 1991.
2. Granin V.Yu. Bases of engineering knowledge in automated design / - Textbook. allowance. - Kharkiv: Nat. aerospace. University “Kharkiv. aviation. Inst. ”, 2005. - 59 р.
3. Automated preparation of programs for CNC machines / R.E. Safragan, G.B. Евгенев, A.Л. Deryabin et al. - K., 1986.
4. Journals "CAD and Graphics", "Information Technology", "Information Technology in Design and Production", "Computer Aided Design and Document Management (EFFICIENCY)", "CADmaster", "CAD / CAM / CAE Observer".

15. Інформаційні ресурси

1. https://sites.google.com/view/vpu406kompas/

2. https://pidru4niki.com/1448022350447/marketing/sistemi_avtomatizovanogo_proektuvannya_produktsiyi