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 р.

CURRICULUM *SELECTIV*
ACADEMIC DISCIPLINE

Computer-aided Design Systems. Part 1

(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, – 12 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)
/4</td><td>Selective</td></tr>
<tr><td>Modules – 2</td><td>Year of preparation:</td></tr>
<tr><td>Content modules – 4</td><td>2021/2022</td></tr>
<tr><td rowspan="2">Individual task not provided</td><td>Semester</td></tr>
<tr><td>1</td></tr>
<tr><td rowspan="2">The total number of hours – 48 / 90</td><td>Lectures *</td></tr>
<tr><td>0</td></tr>
<tr><td rowspan="7">Weekly hours for full-time study:
classroom – 3
independent work of the student – 2,63</td><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 students to perform work on pre-design analysis of objects, processes and design systems during the development of automated systems for design and technological purposes.

The main objectives of the discipline are the formation of students' basic system concepts and skills, a holistic vision of the modern technosphere, strengthening interdisciplinary links, the development of systems thinking, without which the effective use of information technology is impossible.

As a result of studying the discipline the student must

know:

- theoretical and practical bases of methodology of the system analysis concerning scientific and technical and technical and economic tasks of interdisciplinary character;
- principles and methods of target, functional, structural analysis and synthesis of technical objects and automated systems;
- types of models of technical objects and automated systems and principles of their construction, methods and means of construction of object-oriented information (including intelligent) models of systems;
- stages of creation of technical and information systems, engineering content and formal description of the main tasks of their design;
- content and relationship of tasks of target, functional, operational-procedural, informational, structural analysis and synthesis of automated systems;
- purpose and functions of the main modules of integrated business process automation systems of the life cycle of complex technical objects (design, production preparation and production management).

be able:

- apply the methodology of system analysis to solve scientific, technical and technical and economic problems and the development of information systems and technologies;
- to develop system information models of technical objects and business processes of their life cycle, including with the use of CASE-tools, to formulate meaningful and formal tasks of their design;
- perform functional and structural decomposition of objects, processes and design systems;
- determine the feasibility of developing systems for computerization of engineering activities and the composition of functions, tasks, design procedures, information and software;
- to create bases of engineering knowledge of specialized application systems and to generate software modules of designing of technical objects.

The student must acquire basic skills automated synthesis of elements of information and application software of specialized systems by means of basic tool environment.
Interdisciplinary links: English**.**

3. The program of the discipline

Module 1.

Content module 1. PURPOSE AND FUNCTIONS OF AUTOMATED SYSTEMS IN THE LIFE CYCLE OF A TECHNICAL OBJECT.

Topic 1. The life cycle of a technical object. Phases of the product life cycle. The composition and content of the tasks of creating new technology. The composition of data on the technical object by phases of the life cycle.

Topic 2. Systems of automation of a life cycle of technical object. Types of automated systems (AS): design and control automation systems. Functions of systems of design, engineering analysis and technological preparation of production. Functions of control systems of technological and production processes. The role of systems analyst in creating automated systems. The purpose and objectives of the discipline.

Content module 2. SUBJECT AREA AND BASIC CONCEPTS OF SYSTEMS ANALYSIS.

Topic 3. Basic concepts of systems theory. System models. Concepts and features of systems: properties, relations, function, structure. Types of properties of technical systems. Types of system models. Functional and structural description of the system. Varieties of structures of technical and information systems.

Topic 4. Complex systems. Subject and methods of system analysis in engineering. Features of complex systems. Measures of system complexity. Signs of complex systems. Synergistic effect. The subject of system analysis. Methods of system analysis.

Topic 5. Decomposition and aggregation of the system model. General order of decomposition. Directions of decomposition: criterion-target, functional, structural. Aggregation. Types of units in systems analysis.

Topic 6. Information model of technical object. Metamodel of the object class. Hierarchy of objects. Input and output properties. Inheritance of properties. Active object architecture. Relationships and connections of objects. Object property groups.

Topic 7. Types of problems in systems theory. Analysis and synthesis in systems research. Types of system tasks in management and design processes. Variety of synthesis problems. Forms of presentation of design alternatives: morphological tables, structural formulas, conceptual graphs.

Topic 8. Basic concepts of engineering systemology. Methods of classification of systems. Systemological classification. Types of relationships between objects. Ascending systems, data systems, generating systems, structured systems, metasystems.

Topic 9. Basic concepts of design activities. Project, design decision, design documents, design procedures and operations. Decomposition of the design process, projected and projecting systems. Stages of development of a technical object.

Topic 10. System analysis procedures. Processes of creating automated systems (AS). Procedures of analysis and synthesis in the design of the AU. Functional model of system creation. Content and interrelation of system analysis procedures. General characteristics of procedures of target, functional, informational, operational-procedural, situational analysis.

Module 2.

Content module 3. SYSTEM ANALYSIS OF BUSINESS PROCESSES OF COMPUTERIZATION OBJECTS.

Topic 11. Content of design activities. Sequence of change of models of object: need, technical function, functional structure, physical principle of action, technical decision, technological and production processes. Weakly structured design tasks: synthesis of functional structure, schematic diagram, technical outline of the product. The general sequence of design works on stages of development. The relative importance of design solutions at different stages of development.

Topic 12. Problems of automation of design of technical systems. Capabilities and limitations of modern CAD / CAM / CAE systems at different stages of development. Requirements for integration, individualization, intellectualization of CAD. Algorithmic and expert approaches to the formalization of engineering knowledge.

Topic 13. System analysis **processes of information support of project decision making.** Functional structure of intelligent design system. The structure of the database of engineering knowledge (BZ) CAD. Functions of knowledge base generation system. Modules of engineering knowledge (MIZ) and methods of knowledge base. External and internal description of the Ministry of Foreign Affairs. Properties of objects, knowledge base dictionary. Types of knowledge modules: formula, table, database, subroutine. Generation of knowledge modules and methods. Modeling of MIZ work and methods. Relationship of knowledge base methods with the information model of the object.

Topic 14. Target analysisbusiness processes. Goal setting, goal decomposition factors, selection of criteria, coordination of goals and criteria.
Topic 15. System analysis of the functional structure of the system.Organizational and functional

analysis. Functional model of the enterprise. Forms of description of organizational and

functional structures. Design system as an object of development. Generalized functional

structure of CAD. Functional model of the CAD creation process.

Topic 16. System analysis information support solutions. Information analysis. Features of information processes in various automated systems. Forms of description of information structures.

Topic 17. Situational analysis of business processes. Construction of system models of problem situations.Features of situations of design and management activities.

Topic 18. System analysis of solutions for algorithmic software. Operational and procedural analysis. The structure of the design process: stages and stages of design, design procedures, design operations. Hierarchical levels and aspects of design. A typical scheme of the design process at one level: synthesis, analysis, decision making. Design strategies. Principles of construction design routes. Classification of project procedures by content and method of description. Formal, formalized and heuristic procedures.

Content module 4. Uncertainty disclosure IN SYSTEM ANALYSIS PROBLEMS

Topic 19. Disclosure of uncertainties in system analysis problems. Selection procedures. Choice as a decision-making task. Setting the task of decision making. Requirements for measurability of goals. Criteria for evaluating options. Decision making with many criteria.

Methods of linear convolution, use of technical constraints, reduction to a system of nonlinear equations. Pareto compromise principle. Methods and techniques for finding the Pareto set.

Topic 20. System design. Directions of system technical activity. The role of system-wide, basic and applied software in the creation of CAD. The trend of AU integration. Principles of CALS-technology. AU life cycle models.

Topic 21. System methodology of prediction. The place and role of expert evaluation in the methodology of prediction, the creation of scenario analysis as a basis for prediction. Methodological and mathematical principles of prediction, methods and techniques of development and implementation of its strategy. Examples of regional and national technology forecasting programs

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					
Content module 1. Purpose and functions of automated systems in the life cycle of a technical object					
Topic 1. The life cycle of a technical object	3	-	2	-	1
Topic 2. Systems of automation of a life cycle of technical object	3	-	2	-	1
Together on the content module 1	6	-	4	-	2
Content module 2. Subject area and basic concepts of systems analysis					
Topic3. Basic concepts of systems theory. Systems models	3	-	2	-	1
Topic 4. Complex systems. Subject and methods of system analysis in engineering	4	-	2	-	2
Topic 5. Decomposition and aggregation of the system model	4	-	2	-	2
Topic 6. Information model of the technical object	5	-	2	-	3
Topic 7. Types of problems in systems theory	4	-	2	-	2
Topic 8. Basic concepts of engineering systemology	4	-	2	-	2
Topic 9. Basic concepts of design activities	4	-	2	-	2
Topic 10. Procedures of system analysis	4	-	2	-	2
Together on the content module 2	32	-	16	-	16
Total hours for module 1	38	-	20	-	18
Module 2 **Content module 3. System analysis of business processes of computerization objects**					
Topic 11. The content of design activities	4	-	2	-	2
Topic 12. Problems of automation of design of technical systems	3	-	2	-	1
Topic 13. System analysis project decision support processes.	4	-	2	-	2
Topic 14. Target analysisbusiness processes	3	-	2	-	1
Topic 15. System analysis of the functional structure of the system.Organizational and functional analysis.	4	-	2	-	2
Topic 16. System analysis information support solutions	4	-	2	-	2
Topic 17. Situational analysis of business processes	3	-	2	-	1
Topic 18. System analysis of solutions for algorithmic software. Operational and procedural analysis	3	-	2	-	1

Together on the content module 3	**28**	-	16	-	12
Content module 4. Disclosure of uncertainties in system analysis problems					
Topic 19. Disclosure of uncertainties in system analysis problems	8	-	4	-	4
Topic 20. System design	8	-	4	-	4
Topic 21. System methodology of prediction	6	-	4	-	2
Together on the content module 4	22	-	12	-	10
Total hours for module 2	50	-	-	-	22
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.	Application system developer tool environment.	2
2.	Examples of implementation of specialized design systems.	2
3.	Functions of the editor of information models of objects.	2
4.	Development of a structural model of the design object (part 1).	4
5.	Development of a structural model of the design object (part 2).	4
6.	Construction of a conceptual graph of a class of objects (part 1).	4
7.	Construction of a conceptual graph of a class of objects (part 2).	4
8.	Modular control work № 1.	2
9.	Functions of the knowledge base generation system. Examples of implementation of engineering knowledge bases in specialized CAD.	2
10.	Definition and classification of properties of the design object.	2
11.	Creating a dictionary of knowledge base.	2
12.	Determination of functional-logical connections of input and output properties.	4
13.	Creating modules of engineering knowledge such as Formula.	2
14.	Creating modules of engineering knowledge such as Table.	2
15.	Implementation of structural synthesis tasks in the knowledge base.	2
16.	Generation of knowledge base methods (part 1).	2
17.	Generation of knowledge base methods (part 2).	2
18.	Connecting the method to the information model of the object and modeling the system.	2
19.	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.	Functions of the editor of the information model of the object octopus environment. Construction and use of a conceptual graph (metamodel) of an object class.	6
2.	Features of the organization of the process of designing objects of aerospace technology.	8
3.	Generation of knowledge modules of types Formula and Table. Generation of knowledge base methods. Modeling of MIZ work and methods. Relationship of knowledge base methods with the information model of the object.	8
4.	Tools for formalizing geometric knowledge. Types and parameters of geometric and graphic objects. Generation of geometric modeling and graphical derivation programs.	6
5.	IDEF0 functional analysis methodology. Software for functional systems analysis (Design / IDEF, AllFusion Process Modeler (BPWin), Borland Together, ARIS Business Architect, etc.).	8
6.	IDEF1X information analysis methodology. Software tools for information analysis and synthesis of systems (Design / IDEF, ERWin, Model Mart, Meta Base, etc.).	6
	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. System analysis. Lecture notes (in electronic form). 2020 (Edition Kritskiy D.M.).

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 p.
3. 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