Міністерство освіти і науки України
Національний аерокосмічний університет ім. М. Є. Жуковського
«Харківський авіаційний інститут»

Кафедра «Проектування літаків і вертольотів» (№ 103)

ЗАТВЕРДЖУЮ

Керівник проектної групи

_____ О. Г. Гребеніков
(підпис) (ініціали та прізвище)

«02» 09 2020р.

РОБОЧА ПРОГРАМА ВИБІРКОВОЇ НАВЧАЛЬНОЇ ДИСЦИПЛІНИ

Конструювання елементів авіаційної техніки

(назва навчальної дисципліни)

Галузь знань: **13 «Механічна інженерія»**
(шифр і найменування галузі знань)

Спеціальність: **134 «Авіаційна та ракетно-космічна техніка»**
(код і найменування спеціальності)

Освітня програма: **«Літаки і вертольоти»**
(найменування освітньої програми)

Форма навчання: денна

Рівень вищої освіти: перший (бакалаврський)

Харків 2020 рік

Робоча програма «***Конструювання елементів авіаційної техніки***»
(назва дисципліни)

для студентів за спеціальністю 134 «Авіаційна та ракетно-космічна техніка»
освітньою програмою «Літаки і вертольоти»

«02» вересня 2020 р., – 20 с.

Розробники: Рябков В. І., професор каф. № 103, д.т.н., професор
(прізвище та ініціали, посада, науковий ступінь і вчене звання) (підпис)

Гуменний А. М., доцент каф. № 103, к.т.н., доцент
(прізвище та ініціали, посада, науковий ступінь і вчене звання) (підпис)

Робочу програму розглянуто на засіданні кафедри № 103
проектування літаків та вертольотів
(назва кафедри)

Протокол № 1 від «31» серпня 2020 р.

Завідувач кафедри д.т.н., професор О. Г. Гребеніков
(науковий ступінь і вчене звання) (підпис) (ініціали та прізвище)

1. Description of the discipline

<table>
<tr><td colspan="3">Name of the indicator</td><td>Field of knowledge, specialty, educational program, level of higher education</td><td colspan="3">Characteristics of the discipline
(full-time study)</td></tr>
<tr><td colspan="3">Number of credits (semesters):</td><td rowspan="15">Field of knowledge
13
"Mechanical Engineering"
(code and name)

Specialty
134 "Aviation and rocket and space equipment "
(code and name)

Educational program
" Airplanes and helicopters "
(code and name)

Level of higher education:
first (bachelor's)</td><td colspan="3">Cycle of professional training of the student's choice</td></tr>
<tr><td>6th</td><td>7th</td><td>8th</td><td colspan="3" rowspan="2"></td></tr>
<tr><td>8</td><td>4,5</td><td>3</td></tr>
<tr><td colspan="3">Number of modules - 3</td><td colspan="3">Academic year:</td></tr>
<tr><td colspan="3">Number of content modules - 6</td><td colspan="3">2019/2020</td></tr>
<tr><td colspan="3">Individual task
_____
(title)</td><td colspan="3">Semester</td></tr>
<tr><td colspan="3" rowspan="2">Total number of hours - 168/465</td><td>6th</td><td>7th</td><td>8th</td></tr>
<tr><td colspan="3">Lectures, hours</td></tr>
<tr><td colspan="3" rowspan="2">Number of weekly hours for full-time study, hours:
6th semester of classrooms - 64; independent student work - 176,
7th semester of classrooms - 64; independent student work - 71,
8th semester of classrooms - 24; independent student work - 66</td><td>32</td><td>32</td><td>-</td></tr>
<tr><td colspan="3">Practical, seminar, hours</td></tr>
<tr><td colspan="3" rowspan="2">-</td><td>-</td><td>24</td></tr>
<tr><td colspan="3">Laboratory, hours</td></tr>
<tr><td colspan="3" rowspan="2">32</td><td>32</td><td>-</td></tr>
<tr><td colspan="3">Independent work, hours</td></tr>
<tr><td colspan="3" rowspan="2">176</td><td>71</td><td>66</td></tr>
<tr><td colspan="3">Type of control</td></tr>
<tr><td colspan="3" rowspan="2">exam</td><td colspan="2">modular control</td></tr>
<tr><td colspan="3">exam</td><td>Diff. credit</td></tr>
</table>

The ratio of the number of hours of classroom classes to independent work is: 152/313.

*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 the study: the purpose of the discipline "Design of aircraft" is the acquisition by students of knowledge about the features of interaction and interaction of parts, units of units under load, about modern methods of construction and design of structural elements and units of aircraft and helicopters. taking into account the specified resource.

Objectives: the main objectives of the discipline "Design of aircraft" are students to gain knowledge about modern methods of design and construction of structural elements and components of the wing, plumage, fuselage, chassis, control system (spars, stringers, ribs, brackets, plating, frames, butt units, panels, rods of the control system, rocking chairs, trays, shock absorbers, etc.) on the condition of minimum weight, as well as the principles and rules of rational design in aircraft construction, design of detachable and non-detachable connections.

Learning outcomes.

As a result of studying the discipline the student must

***know*: the**

- principles and rules of rational design in aircraft and helicopter construction;
- main stages of design of ACP objects;
- methods of designing and constructing elements of aircraft structures of minimum mass;
- methods of designing structural elements and components taking into account the specified resource;
- methods of selection of construction materials;
- methods of selection of structural and power schemes of the wing, plumage, steering surfaces, fuselage, chassis, control system;
- documentary structure of the design project, design and operational documentation;

***be able to*:**

- competently, taking into account the existing recommendations to choose:
  - construction material;
  - structural and power schemes of wings, plumage, steering surfaces, ailerons, fuselage, chassis;
  - structural and power schemes of mechanization, control systems;
- to carry out design calculations of structural elements and units of aircraft and helicopter units according to the criterion of minimum mass;
- to carry out rational design of details and knots of the glider;
- take into account when designing parts technological methods of their manufacture.

Interdisciplinary links: the course is related to the disciplines "Engineering basics of aviation and rocket and space technology", "General structure of aviation and

rocket and space technology", "Design of aircraft units", "General design of aircraft and helicopters", "Integrated design of airplanes and helicopters ".

3. The program of the discipline

Module 1.

Content module 1.

General questions of designing elements of aviation equipment

Topic 1. Introduction. The purpose and objectives of the course. Requirements for aircraft and helicopter designs. General issues of designing elements of aircraft.

Definitions and tasks of design. Requirements proposed by the Aviation Rules (AP) for the design of aircraft elements (helicopter). The content and importance of design at the main stages of the creation of the aircraft (helicopter): preliminary design, sketch design, working design. Tasks that need to be consistently solved at the stages of preliminary, sketch and working design, respectively.

Features and problems of design and construction. Ways to overcome problems. The equation of existence of the aircraft. The relationship between the characteristics of the aircraft and its mass. The minimum weight of the aircraft is the basis for ensuring high flight performance. The role and tasks of structural and power layout. The law of "square - cube" and the problems of optimizing the power structure of parts, units of aircraft (helicopter). Influence of the level of design of the power structure, engine and power plant on the takeoff mass of the aircraft.

Economic evaluation of design and engineering decisions. Gradient method for estimating STC. Cost equivalents of change in mass, speed, drag, aerodynamic quality and resource. Use of mass equivalent of cost for definition of size of the resulted expenses and an estimation of expediency of modification of a design at simultaneous change of weight and cost of the unit.

Topic 2. Concepts, principles and rules of rational design in aircraft and helicopter construction.

Classification of principles and rules of rational design in aircraft construction.

The principle of maximum economic efficiency. Groups of rules for the implementation of this principle: the minimum cost of development and design, the minimum cost in serial production, the minimum cost of operation. Directions and ways to achieve these rules.

The principle of minimum construction weight. The main rules for implementing this principle: the rule of "lazy"; rational choice of design loads; load management; combination of functions by details, knots and units; conformity of the form of cross sections of elements to loading; maximum diversity of masses. Organization of the previous stress-strain state; the rule of equivalence and its main aspects (equality of destructive forces for all elements in a series chain of load transfer, equality of destructive forces for one element at stretching at different types of its destruction),

equality of destructive forces for one element at work on compression in the form of equality of stresses of various forms of loss of stability, beams of equal resistance, uniformity of loading in multirow connections); desired types of deformations; monolithicity, local strengthening; rule of "culture" of design and its aspects.

The principle of aerodynamic perfection. Rules for implementing this principle: the most advantageous aerodynamic layout, minimum aerodynamic drag ($C_x \oplus S$) (creation of structures with a minimum area of the midline; no parts protruding into the flow; perfection of aerodynamic shapes; no parasitic flows and disruptions of air flows); energy perfection of aircraft aerodynamics; ensuring the most advantageous interference; reduction of friction resistance, minimal focus shift; ensuring sufficient structural rigidity.

The principle of production and technological perfection. Selection of the simplest blanks, reasonable purpose of accuracy, articulation, use of open milk, easy to process materials, integrally stamped, cast, monolithic panels and details, providing convenient approaches at assembly.

The principle of operational excellence. The basic rules of realization of this principle: convenience of installation, dismantle and service of the plane (helicopter), possibility of operation of the plane in various climatic conditions, maintainability and operational manufacturability, fuel economy.

The principle of survivability and provision of a given resource. Rules for implementing this principle: rational choice of material, rational organization of VAT (reduction of stress levels, reduction of tensile stresses, use of radial tension, reduction of stress concentration, spacing of concentrators and their transfer to the zone of small or mainly compressive stresses, increase of compression package shear connection), reducing the intensity of fretting corrosion, the rule of plastic deformation.

Additional rules to ensure maximum survivability - safe destruction: multiple load transfer paths (statically indeterminate systems, working cladding, duplication, redundancy), the rule of "weak link", the use of destruction limiters (titanium tapes on monolithic panels, the use of prefabricated structures, articulation monolithic design on sections, etc.).

Topic 3. Basics of designing structural elements taking into account durability and resource.

The reasons of the increased attention and resource and durability of details, knots and units of aircraft designs. The reasons for the destruction of elements under the action of time-varying loads and the problem of ensuring durability and resource. Load parameters. Theoretical concentration factor, its dependence on the geometry of the concentrator, the level of load of the element, the load of the joints and the presence of tension in them. Weller curve. Endurance limit on a symmetrical and pulsating cycle.

Effective concentration factors. The concept of effective concentration coefficients, their dependence on the asymmetry of the load cycle, the type of concentrator, surface condition, load level and durability. Evaluation of the durability of elements made of aluminum alloys. Evaluation of the durability of structural

elements made of steel. Calculation of durability at casual loading. Linear theory of summation of fatigue damage.

Modular control.

Content module 2.

Design of elements and units of wings and plumage

Topic 1. Selection of materials for structural elements.

Properties of materials. Requirements proposed for stretching, shear, torsion, longitudinal and transverse bending, under the action of time-varying loads. Comparative characteristics of construction materials. The concept of specific strength and specific hardness. Choice of construction materials. Aluminum alloys. Magnesium alloys. Titanium alloys. Alloy and low-alloy steels. Heat-resistant aviation structural steels. Composite materials (CM).

Topic 2. Construction of connections of elements of aircraft structures.

Types of detachable connections. Fixed, sedentary and mobile connections, features and design. Types of integral connections.

Riveting joints, their types and requirements. Features of a design and technology of performance of riveted connections. Features of design and calculation. Ways to increase the life and tightness of riveted joints. (Structural, technological, constructive-technological.)

Bolted connections. Their features, advantages and disadvantages of bolted connections. Features of work, design and calculation of serious connections and the connections working on separation. Calculation of the group of connections when applying a load, by shifting the axis of the load transfer relative to the center of mass. Ways to increase the life of bolted joints.

Welded joints, features of their manufacture and application, requirements to them, recommendations on application, design calculations of butt and lap joints. Advantages and disadvantages of welded joints. Adhesive joints, their advantages and disadvantages, the choice of basic parameters of joints. Features of connections of elements of designs with KM (composite materials).

Topic 3. Construction of elements and units of wings and plumage.

Design of spars. Structural-strength and technological features of spars. Design of belts of beam side members of minimum weight. Algorithm for selecting parameters of compressed and stretched belts. Design of walls of spars of minimum weight, calculation algorithm. Features of designing connections of a belt of a spar with a covering and a wall.

Design of ribs. Structural and technological features of ribs. Normal ribs, their functions, nature of loading, calculation scheme. Determination of rib reactions, construction of plots of internal forces (Q, M_{cr}). Choice of parameters of beam ribs. Features of designing belts and walls. Reinforced ribs, design of belts and walls.

Design of suspension brackets for steering surfaces and ailerons. Functions of brackets and their constructive and technological features, nature of loading,

calculation scheme, construction of plots of efforts. Choice of parameters of a belt and a wall of an arm. Calculation of connection of an arm with power ribs and a wall of a spar of a wing (plumage).

Modular control.

Module 2.

Content module 1.

Design of butt joints and panels of the wing, plumage and fuselage

Topic 1. Design of butt joints and panels of the wing and plumage.

Design of panels. Panel functions. Types of panels on a design and ways of production. Prefabricated panels, their types. Advantages and disadvantages of prefabricated panels. Design of prefabricated panels. Choice of stringer design. Their functions and design and technological features. Bearing possibility of stringers. Design of wing sheathing. Their functions, workload and operation. Choice of sheathing thickness. Types of connections, requirements for connections.

Monolithic panels. Methods of obtaining monolithic panels. Advantages and disadvantages of monolithic panels. Design of monolithic panels of minimum weight. Choice of distance between ribs. Algorithm of design calculation.

Multilayer constructions, their advantages and disadvantages. Ways to increase the mass efficiency of three-layer structures.

Construction of butt joints of a wing and plumage. Design features of butt joints. Their types are constructive execution for cases of point and contour joint. Design and calculation of bolts of ears of a forked joint knot. Algorithm of design calculation of butt knots with horizontal and vertically located bolts. Features of a design and calculation of butt knots of caisson and monoblock wings.

Topic 2. Design of elements and components of the fuselage.

Purpose, functions, load, calculation scheme. Design calculation of beam-stringer fuselage: casing thickness, pitch, type and area of stringers. Structural and strength features of normal frames. Design calculations of normal frames: height and thickness of a wall, width and thickness of the shelf. Reinforced frames: purpose, functions, load, design features. Calculation scheme, determination of internal efforts and determination of parameters. The choice of the form and the sizes of elements of a design of frame frames from a condition of a minimum of weight. Algorithm of design calculation. Butt frames. Design of appropriate components for the wing, plumage and chassis.

Modular control.

Content module 2.

Design of elements and components of the chassis of aircraft and helicopters

Topic 1. Selection and justification of the scheme and type of chassis.

Purpose, functions. Design tasks. Selection of composite chassis diagrams. Selection of the basic geometrical parameters of the chassis. Choice of number of supports and wheels. Kinematic schemes of assembly - chassis release. External loads acting on the chassis. Choice of structural and power chassis risers. Determination of the main parameters of liquid-gas shock absorbers. Design of elements and components of the chassis structure taking into account fatigue and wear.

Consideration of various chassis schemes (with tail or nose support, bicycle scheme), analysis of their advantages and disadvantages. The choice of geometric parameters of various schemes (position of the main, bow or tail struts of the chassis relative to the center of mass, the choice of longitudinal and transverse bases taking into account the type of aircraft and its VPH, and the height of the center of mass from the runway surface).

Topic 2. Determination of loads on the main and auxiliary racks. Wheel selection.

Consideration of design cases, which are recommended by the norms of strength and AP. Determination of loads acting vertically, along the aircraft (helicopter) and sideways, taking into account the speed of movement in the vertical and horizontal planes, the type of aircraft, and its weight.

Topic 3. Selection and justification of the structural and power scheme of the chassis.

Types of structural and power schemes of the chassis, their advantages and disadvantages. The choice of KSS taking into account the loads and placement of the chassis, its layout (wing, fuselage), taking into account whether the chassis rack is removed or not removed in flight.

Topic 4. Determining the required energy consumption of shock absorbers of the chassis struts. Selection and substantiation of the type of shock absorber and determination of its energy-power and design parameters.

Determining the amount of kinetic energy that must be absorbed when landing an aircraft. Distribution of this energy between the main and auxiliary racks. Next, the distribution of energy between the tires and shock absorbers. Calculation of the shock absorber stroke and its diameter taking into account its type, position on the support, and the type of wheel suspension (lever, semi-lever, etc.).

Topic 5. Design calculation of structural elements of the chassis, taking into account fatigue and wear.

Design of chassis attachments. Designing withэассоχιατιονсchassis design elements together. Design taking into account the degree of their mobility and fatigue and wear.

Modular control.

Content module 3.

Design of elements and mechanisms of the aircraftcontrol system and helicopter

Requirements of the AP for the design of aircraft and helicopter control systems.

Purpose, functions. Basic and additional control systems. Tasks of design calculations. Kinematic calculation of the control system. Design of linear elements of aircraft structures. Thrust design, taking into account the conditions of strength and resonant oscillations, wiring deformations, heating effects. Methods of combating deformations of control system elements. Flexible wiring, design features, advantages and disadvantages. Design of rocking chairs and bushings of the control system.

Topic 1. Purpose, functions and requirements for the control system of aircraft and helicopters.

Topic 2. Kinematic calculation of the control system.

Topic 3. Determination of loads acting on the structural elements of the control system and construction of effort diagrams.

Topic 4. Design calculation of structural elements of the control system (command levers, rods, rocking chairs, etc.).

Topic 5. Features of designing structural elements of flexible wiring of the control system.

Modular control.

Module 3.

Content module 1.

Execution of a course project on the topics: "Design of elements and components of the mechanical channel of the main control" or "Design of elements and components of the chassis rack".

4. The structure of the discipline

Name of the content module and topics	Number of hours				
	Total	Including			
		l	p	lab.	with. p.
1 Module					
1 content modules. ***General issues of designing elements of aviation equipment***					
Topic 1. ***Introduction. The purpose and objectives of the course. Requirements for aircraft and helicopter designs. General questions of designing elements of aviation equipment***	24	2	-	-	25
Topic 2. ***Concepts, principles and rules of rational design in aircraft and helicopter construction***	28	6	-	-	25
Topic 3. ***Fundamentals of design of structural elements taking into account durability and resource***	28	2	-	-	26
Modular control	2	2	-	-	-
Together on the content module **1**	**82**	**12**	-	-	**76**
Content module 2. ***Construction of elements and units of wings and plumage***					
Topic 1. ***Selection of materials for structural elements***	28	2	-	4	26
Topic 2. ***Designing connections of elements of aircraft structures***	28	4	-	6	18
Topic 3. ***Design of elements and units of a wing and plumage***	70	12	-	22	56
Modular control	2	2	-	-	-
Together on the content module **2**	**128**	**20**	-	**32**	**100**
Total hours	**210**	**32**	-	**32**	**176**
Module 2					
Content module 1. ***Design of butt joints and panels of the wing, plumage and fuselage***					
Topic 1. ***Design of butt joints and wing panels and plumage of aircraft***	14	6	-	6	12

Topic 2. ***Design of elements and units of the fuselage***	20	8	-	6	12
Modular control	2	2	-	-	-
Together for the content module **1**	**36**	**16**	**-**	**12**	**24**
Content module 2. ***Design of elements and units of the chassis of aircraft and helicopters***					
Topic 1. ***Selection and justification of the scheme and type of chassis***	10	4	-	4	4
Topic 2. ***Determination of loads on the main and auxiliary racks. Wheel selection***	12	4	-	8	2
Topic 3. ***Selection and substantiation of the structural and power scheme of the chassis***	10	2	-	6	4
Topic 4. ***Determination of the required energy consumption of the shock absorbers of the chassis struts. Selection and substantiation of the type of shock absorber and determination of its energy-power and design parameters***	16	6	-	6	6
Topic 5. ***Design calculation of chassis construction elements taking into account fatigue and wear***	17	6	-	10	8
Modular control	2	2	-	-	-
Together on the content module **2**	**67**	**24**	**-**	**34**	**24**
Content module 3. ***Design of elements and mechanisms of the aircraft and helicopter control system***					
Topic 1. ***Purpose, functions and requirements for the control system of aircraft and helicopters***	4	2	-	-	6
Topic 2. ***Kinematic calculation of the control system***	8	4	-	4	4
Topic 3. ***Determination of loads acting on the structural elements of the control system and construction of force diagrams***	4	2	-	6	2
Topic 4. ***Design calculation of structural elements of the control system (command levers, rods, rockers, etc.)***	8	4	-	4	6

Topic 5. ***Features of the design elements of the flexible wiring of the control system***	6	2	-	4	5
Modular control	2	2	-	-	-
Together on the content module 3	**32**	**16**	-	**18**	**23**
Total hours	**135**	**32**	-	**32**	**71**
Module 3					
Content module 1. *Course project*					
Execution of a course project on the topics: "Design of elements and components of the mechanical control channel of the main control" or "Design of elements and components of the chassis rack"	90	-	24	-	68
Total for the content module 1	**90**	**-**	**24**	**-**	**68**
Total hours	**90**	**-**	**24**	**-**	**68**

5 Seminar topics

№ n / a	Name of topic	Number of hours
1	*Not provided by the program*	
2		
	Total	

6. Topics of practical classes

№ n / a	Name of topic	Number of hours
1	Execution of a course project on topics: "Design of elements and units of the mechanical control channel of the main control" or " Construction of elements and units of the chassis rack "(module 3, 8th semester)	90 (room 24; self-68)
	Total	90

study7. Topics of laboratory classes

№ s / n	Topic name	Number of hours
Module 1		
Content module 2 (6semester)		
1st1–2	Choice of construction materials	4
3–5	Design of joints of elements of aircraft structuresmembers	6
6–9	Design of side	8
10–13	Design of wing ribs	8
14–15	Design of aileron mounting brackets and steering surfaces	4
16	Automated selection of the distance between the hinges of the moving parts of the wing and plumage	2
	Together for the 6th semester	**32**
Module 2		
Content module 1 (7th semester)		
1-2	Design of butt joints	4
3-5	Design of wing panels	6
6	Design of power frames	2
Content module 4 (7th semester)		
7–10	Type selection and development of power and kinematic schemes of the chassis	8
11–14	Determination of loads on chassis struts and selection of wheels	8
15–19	Construction of chassis shock absorbers	10
20–23	Construction of articulated double chassis	8
Content module 5 (7th semester)		
24–27	Development of a kinematic control scheme	8
28–32	Construction of control system elements	10
	Together for the 7th semester	**64**

8. Independent work

№ s / n	Topic title	Number of hours
	Module 1	
	Content module 1	
1	Composition and structure , content and significance of design at the main stages of creation of aircraft (preliminary design, sketch design, working design)	25
2	Content of the principles of production, technological and operational excellence	25
3	The process of fatigue failure and its characteristics. The concept of effective stress concentration coefficients in structural elements	26
	Content module 2	
4	Modern composite materials and their application in the design and construction of aircraft elements	26
5	Types of connections used in the design of aircraft elements. Combined connections	18
6	Structural and power schemes of bearing surfaces of aircraft, features of their choice depending on the type of aircraft. Features of designing units of bearing surfaces.	56
	Module 2	
	Content module 1	
7	Types of panels and joints on modern aircraft. Features of their design depending on the type and purpose of aircraft	12
8	Types of panels and joints in the fuselage structures of modern aircraft. Features of their design depending on the type and purpose of aircraft	12
	Content module 2	
9	Types of chassis of modern aircraft	4
10	Choice of types of tires depending on the purpose and basis of aircraft	2
11	Choice of KSS chassis depending on the takeoff and landing characteristics of the aircraft	4
12	Types shock absorbers used in the chassis of modern aircraft	6
13	Types of wear in the joints of chassis elements	8
	Content module 3	

14	Types and composition of modern aircraft control systems	6
15	Kinematic schemes of control systems of modern aircraft	4
16	Types of loads on the elements of mechanical control channels	2
17	Design features of command levers in the cockpit	6
18	Types and geometrical characteristics of cable wiring used in the control system of the aircraft	5
	Content module 6	
19	Features of design of elements and units of the mechanical channel of the main control and elements and assemblies of chassis struts	68
	Total	**313**

9. Individual task

№ s / n	Topic name	Number of hours
Module 1		
Content module 2		
1	Calculation and graphic work: design of the wing spar	-
Module 2		
Content module 1		
2	Calculation and graphic work: design of compressed wing panels.	-
Module 3		
Content module 1		
2	Course project on "Design of elements and components of the mechanical control channel of the main control" or "Design of elements and components of the chassis rack"	-

10. Teaching methods

Conducting classroom lectures, laboratory work, practical classes, individual consultations (if necessary), independent work of students on the materials published by the department (manuals) and leading aviation organizations, the use of Internet materials and electronic materials posted on the website of the department, the first round of the Olympiad in the specialty.

11. Methods of control

Carrying out current control, written modular control, final control in the form of exams and defense of course projects.

12. Evaluation criteria and distribution of points received by students

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

Components of educational work	Points for one lesson (task)	Number of classes (tasks)	Total number of points
Module 1			
Content module 1			
Execution and defense of laboratory (practical) works	-	-	-
Modular control	0… 10	2	0… 20
Content module 2			
Execution and defense of laboratory (practical) works	0… 10	6	0… 60
Modular control	0… 10	2	0… 20
Total for the 6th semester			**100**
Module 2			
Content module 1			
Execution and defense of laboratory (practical) works	0… 3 0… 4	2 1	0… 10
Modular control	0… 5	2	0… 10
Content module 2			
Execution and protection of laboratory (practical) works	0… 5	4	0… 20
Modular control	0… 10	2	0… 20
Content module 3			
Execution and defense of laboratory (practical) work	0… 10	2	0… 20
Modular control	0… 10	2	0… 20
Total for the 7th semester			0…**100**
Module 3			
Content module 1			
Execution and defense of the course project	0… 100	1	0… 100

Total for the 8th semester	0…**100**

Semester control (exam) is held in case of refusal of the student from b of current testing and in the presence of admission to the exam. During the semester exam the student has the opportunity to receive a maximum of 100 points.

The ticket for the exam consists of two theoretical questions, with a maximum score of 50 points per question.

12.2. Qualitative evaluation criteria The

required amount of knowledge to obtain a positive assessment:

- principles and rules of rational design in aircraft and helicopter construction;
- main stages of design of ACP objects;
- methods of designing and constructing elements of aircraft structures of minimum mass;
- methods of designing structural elements and components taking into account the specified resource;
- methods of selection of construction materials;
- methods of selection of structural and power schemes of the wing, plumage, steering surfaces, fuselage, chassis, control system;
- documentary structure of the design project, design and operational documentation;

The required amount of skills to obtain a positive assessment:

- competently, taking into account the existing recommendations to choose:
  - construction material;
  - structural and power schemes of wings, plumage, steering surfaces, ailerons, fuselage, chassis;
  - structural and power schemes of mechanization, control systems;
- to carry out design calculations of structural elements and units of aircraft and helicopter units according to the criterion of minimum mass;
- to carry out rational design of details and knots of the glider;
- take into account when designing parts technological methods of their manufacture.

12.3 Criteria for evaluating student work during the semester

Satisfactory (60-74). Have a minimum of knowledge and skills. Work out and defend all laboratory work and homework.

Good (75 - 89). Firmly know the minimum knowledge, perform all tasks. Demonstrate the ability to perform and defend all laboratory work within the period specified by the teacher with a justification of the decisions and measures proposed in the work.

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

Distribution of points received by students for course work (project).

Explanatory note	Illustrative part	Work protection	Amount
up to 40	up to 40	to 20	100

scale: point and traditional

Sum of points	GradingGrade according to the traditional scale	
	Exam, differentiated test	Credit
90 - 100	Excellent	Credited
75 - 89	Good	
60 - 74	Satisfactory	
0 - 59	Unsatisfactory	Not credited

13. Methodical support

Lecture notes and literature in the library , methodical office and in electronic form on the server of the department of aircraft and helicopter design (the list is given below in section 14 of this program).

14. Recommended Books

Basic:

1. Кривцов, В.С. Конструкция самолетов и вертолетов [Text]: учебник / В.С. Кривцов, Л.А. Malashenko, VL Malashenko, SV Трубаев. - Н .: Nat. aerospace Univ. NOT. Zhukovsky "Kharkov. Aviation. Inst.", 2010. - 366 pp.
2. Development of the preliminary design of the aircraft [Text]: textbook / AK Myalitsa, LA Malashenko, AG Grebenikov and others - H.: Nat. .erospace Univ. NOT. Zhukovsky "Kharkov. aviation. Inst. ", 2010. - 233 pp.
3. General design of helicopters / VS Krivtsov, JS Karpov, LI Losev. - Textbook. - Kharkiv: Nat. aerospace University" Kharkov. aviation. in-t », 2003. - 344p.
4. Losev, LI Разработка аванпроект вертолета [Text]: учеб. allowance / LI Losev, AG Grebenikov, L.R. Dzhemilev et al. - Н .: Nat. aerospace Univ. NOT. Zhukovsky "Kharkov. Aviation. In-t", 2012. - 324 pp.
5. Ryabkov, VI Device and choice of aircraft chassis parameters [Text]: textbook / VI Ryabkov, VA Trofimov, V .N. Pavlenko et al. - Н .: National Aerospace University "Kharkov. aviation. ин-т », 2010. - 344 с.
6. Евсеев, Л.А. Calculation of the strength of the wing of large elongation [Text]: textbook. allowance / L.A. Evseev - Н .: Khark. aviation. Inst., 1985. - 106 p.
7. Евсеев, Л.А. Calculation of the chassis of the aircraft for strength [Text]: textbook. allowance / L.A. Евсеев, К.В. Миронов, П.А. Fomichev. - Н .: Khark. aviation. Inst., 1988. - 100 p.
8. L.V. Капитанова, В.Н. Николаенко, А.А. Redko, VN Рябков, С.В. Трубаев, Т.П. Tseplyaeva Design of airplane wing spars. - Kharkiv .: Nat. aerospace University “Kharkov. aviation. Inst. ”, 2006. - 72p.

9. Malashenko LA, Ryabkov VI Kobylyansky AA, Lebedinsky AG, Sinkevich MV Design of details, knots and units of the plane (uch. Manual on laboratory workshop) .- Kharkov: KHAI, 1987, 102 p.
10. Arson LD, Ryabkov VI, Tseplyaeva TP Design of spars (uch. Manual) Kharkiv: KHAI, 1981, 67 p.
11. Arson LD, Klimenko VN, Pekhterev VD Design of compressed panels Kharkiv: KHAI, 1980, 32 p.
12. Fedotov MN, Ryabkov VI, Panasenko BA Design of elements of aircraft structures. ↓ Kharkiv: KHAI, 1987, 86 p.

Auxiliary:

1. Arson LD, Ryabkov VI, Kobylyansky, AA Design of wing assemblies. Kharkiv :, 1969, 32 p.
2. Arson LD, Lebedinsky AG Redko AA Design of power frames (accounting manual). ↓ Kharkiv: KHAI, 1978, 44 p.
3. Grebenkov OA Aircraft construction. ↓ M .: Mashinostroenie, 1984, 240 p.
4. Grebenikov AG, Arson LD Questions of design of shear bolted connections of a wing taking into account endurance. - Kharkiv: KHAI, 1981. 112 s.
5. Gaidachuk BE, Karpov JS etc. Design of connections of elements of a design l.a. из (КМ) .- Харьков: ХАИ, 1983, 103 с.
6. Zaitsev VN, Rudakov. V.L. Construction and strength of aircraft. ↓ Kiev,
7. Higher School, 1976. 487 p.
8. Fedotov MN Design of connections of elements of aircraft designs (accounting manual). Kharkiv: KHAI, 1973. 72 p.

15. Information resources

1. Site of the Department of Aircraft and Helicopter Design http://k103.khai.edu/uk/.
2. Server of the Department of Aircraft and Helicopter Design.
3. Internet resources