Ministry of Education and Science of Ukraine
National Aerospace University. M.E Zhukovsky
Kharkiv Aviation Institute

Department of Aircraft and Helicopter Design (№ 103)

APPROVED

Guarantor of educational program

(signature) M. M. Orlovskyi (initials and surname)

« 30 » August 2022

SELECTIVE WORK PROGRAM
EDUCATIONAL DISCIPLINE

Structure and Strength of Aircrafts

(title of discipline)

Field of knowledge: 27 «Transport»
(code and title of field of knowledge)

Specialty: 272 «Aviation Transport»
(code and title of specialty)

Educational program: «Maintenance and Repair of Aircrafts and Aviation Engines»
(title of educational program)

Form of study: Full-time

Level of higher education: First (Bachelor's)

Kharkiv 2022

Graduation program «Structure and Strength of Aircrafts»
(title of discipline)

for students of specialty: 272 «Aviation Transport»
educational program: «Maintenance and Repair of Aircrafts and Aviation Engines»

Developers: Taranenko I.M. Professor, Ph.D., Ass. Professor, Dept. 403
(surname and initials, position, academic degree and academic title

(signature)

« 30 » Aug 2022, 13 p.

The work program was considered at a meeting of the Department of Aircraft and Helicopter Design
(name of the department)

Minutes № 1 of "30" Aug 2022.

Head of Department Ph.D., Associated Professor _____ A. M. Humennyi
(degree, scientific degree) (signature) (initials and surname)

1. Description of the discipline

<table>
<tr><td>Name of indicators</td><td>Field of knowledge, specialty, educational program, level of higher education</td><td>Characteristics of the discipline (full-time)</td></tr>
<tr><td>Credits – 4</td><td>Field of knowledge
27 «Transport»
(code and title)</td><td>Optional</td></tr>
<tr><td>Modules – 2</td><td rowspan="2">Specialty
272 «Aviation transport»
(code and title)</td><td>Academic year:</td></tr>
<tr><td>Substantial modules – 2</td><td>2022/2023</td></tr>
<tr><td>Individual task
CGW «Development of aircraft (helicopter) take-off weight»
(title)</td><td rowspan="2">Educational program
«Maintenance and Repair of Aircrafts and Aviation Engines»
(name)</td><td>Semester
5-th</td></tr>
<tr><td>Total hrs – 120
classroom hours * / total hrs – 64 / 120</td><td></td></tr>
<tr><td rowspan="9">Number of weekly hours for full-time study:
classroom – 4
student individual work – 3,5</td><td rowspan="9">Level of higher education:
senior (bachelor)</td><td>Lectures</td></tr>
<tr><td>48 hrs</td></tr>
<tr><td>Practical, Seminars</td></tr>
<tr><td>16 hrs</td></tr>
<tr><td>Labs</td></tr>
<tr><td>–</td></tr>
<tr><td>Individual work</td></tr>
<tr><td>56 hrs</td></tr>
<tr><td>Type of control</td></tr>
<tr><td>pass</td></tr>
</table>

The ratio of the number of hours of classroom classes to independent work is for full-time study – 64/56.

2. The Purpose and Objectives of the Discipline

The purpose of teaching the discipline "General arrangement of aerospace and space technology" is to give the necessary level of knowledge about the purpose and general structure of the main units and systems of aircraft and helicopters, to teach comparative analysis of products of similar purpose but different design

Task

The main tasks of studying the discipline "General arrangement of aviation-rocket and space technology" are

Gain knowledge about the general arrangement of aircraft, helicopters and unmanned aerial vehicles, the basic requirements for them, the main types of structural and power schemes, their advantages and disadvantages,

According to the requirements of the educational-professional program, students must achieve the following competencies:

General competencies (GC):

GC 1. Knowledge and understanding of the subject area and understanding of professional activity.

GC 2. Ability to abstract thinking, analysis and synthesis.

GC 3. Creativity, initiative, entrepreneurship and ability to work in a team.

GC 4. Ability to assess and ensure the quality of work performed.

GC 5. Forecasting the consequences of their activities from the standpoint of unacceptable deterioration of the environmental situation and the emergence of danger to human health.

GC 6. Internal need for purposeful improvement of professional knowledge and skills during training and professional activity.

GC 8. Practical use of a foreign language in professional spheres of communication.

Professional competencies of the specialty (FC):

FC 1. The use of mathematical apparatus in solving problems in the field of design and manufacture of structures.

FC 2. Ability to describe the interaction of bodies with each other, as well as with the gas and hydraulic environment on the basis of basic knowledge in the main sections of physics, mechanics, electrostatics, electrodynamics, optics, aerohydrodynamics.

FC 3. Ability to set and solve problems of designing the parameters of products and processes of their production;

FC 4. Ability to assess the load on the structural elements based on the conditions of their operation

FC 5. Ability to calculate the elements of aerospace and rocketry, including composite materials using knowledge in the field of mechanics and strength of materials and structures.

FC9. Ability to use appropriate software (programming languages, packages) for physical and mathematical calculations in the field of design and manufacture of aircraft structures

FC 11. Ability to develop typical technological processes for the production of elements of aviation and rocket and space technology.

FC 12. Develop technical and design documentation for the manufacture of basic elements of AC

Program learning outcomes:

PRN 1. Ability to mathematical and logical thinking, knowledge of basic concepts, ideas and methods of fundamental mathematics and the ability to use them in solving specific problems

PRN2. Assessment of modern processes and problems of social development from the standpoint of the natural science nature of society

PRN 4. Knowledge of modern information and communication technologies to the extent sufficient for training and professional activities.

- PRN 14. Development of design documentation, sections of explanatory notes of works of sketch projects of average complexity of elements of ACP products and construction of the drawing by existing methods on the basis of normative documents and operating standards, including with use of means of automation of design works.
- As a result of studying the discipline the student must
- know:
- aerodynamic layout schemes of aircraft;

- • advantages and disadvantages of helicopter aircraft of different layout schemes;
- • purpose and general structure of the main systems and units of aircraft;
- • rational areas of application of various structural and power schemes of units;
- • methods and means of improving the take-off and landing characteristics of aircraft ;
- • methods and means of improving the airtightness characteristics of aircraft and helicopters;
- • advantages and disadvantages of different engine layout options for aircraft and helicopters.
- be able to:
- • analyze the requirements for the main units of aircraft and helicopters to determine the general ways of their satisfaction;
- • perform sketches of elements and components of real structures;
- • to determine the structural and power schemes of real units of aircraft structures
- have an idea:
- - on trends in the development of aviation and rocket and space technology;
- - on the rational use of different types of aircraft for aircraft;
- - promising materials for ARCT products.

3. Interdisciplinary relations

Prerequisites – The course is based on the knowledge gained in the study of Physics, Chemistry, Mathematics, Descriptive Geometry and Engineering Graphics, Theoretical Mechanics, Theory of Mechanisms and Machines, Machine Parts, Resistance of Materials, Materials Science.

Corequisites – Aero-Hydro-Gas-Dynamics, Dynamics of Flight, Hydraulics, Design of Aviation Objects.

4. The contents of discipline
Substantial module № 1 Design and Strength of Airplanes

TOPIC 1. Introduction. Classification of airplanes.

Introduction. The subject and tasks of discipline. The place of discipline in syllabus. Airplanes classification. Airplanes classification by aerodynamic scheme (normal, «canard», «tailless», «flying wing», converted, longitudinal triple-plane, tandem). Advantages and disadvantages of each scheme.

Classification of airplanes by structural features (quantity and position of wings, wing type and attachment to fuselage, quantity and position of engines, landing gear arrangement scheme.

General requirements to airplane structure. «Aviation rules». Air codex. Requirements of aerodynamics, strength, rigidity, minimal mass, manufacturability, operation, reliability, survivability, lifetime, economic efficiency, ecology. Contradictions of requirements and methods of their elimination. Variability of design.

TOPIC* 2 . *Wings.

Objective of wing. Requirements to wing. Wing geometrical parameters. Wing shape in plane. Advantages and disadvantages of different shapes. Wing shapes from the front view. Lateral «V» (positive, negative). Low-plane, mid-plane, high-plane wings. Advantages and disadvantages. Wing loading.

Wing airfoils. Parameters, types, fields of application. Advantages and disadvantages of each shape. Supercritical airfoil.

Wing loading. Main elements of load-carrying scheme. Their structure, operation under loading, strength fulfilling.

Longitudinal and lateral wing load-carrying elements. Wing-spars. Application, load-carrying scheme and wing-spar. Rib load-carrying scheme and application.

Wing longitudinal false spars. Application, design. Skin structure and application. Stringers structural-technological scheme, shape. Panels. Assembled, monolithic, sandwich. Their advantages and disadvantages. Fields of application.

Wing load-carrying-schemes. Wing-spar load-carrying scheme. Structural realization, loading scheme. Fields of application.

Wing-box wings. Structural realization, loading scheme. Fields of application.

Monoblock wings. Structural realization, loading scheme. Fields of application. Comparative analysis of wings with different load-carrying schemes.

Arrow-like wings. Fields of application. Advantages, disadvantages. Load-carrying schemes of arrow-like wings. Distinctions of attachment to fuselage. Arrangement of longitudinal and lateral members in arrow-like wings. Advantages and disadvantages of different variants of members arrangement from strength point of view.

Swept back wings. Their advantages and disadvantages. Structural distinctions. Triangular wings. Fields of application. Advantages, disadvantages. Arrangement of longitudinal and lateral members in triangular wings.

TOPIC* 3** . ***Fastening elements. Joints. Attachment fittings.

Design of fastening elements. Distinctions of their design. Riveted joints. Rivets design. Distinctions riveted joints design. Fastening elements for specific structures. Soldering. Advantages, disadvantages. Welding. Advantages, disadvantages. Adhesive joints. Advantages, disadvantages.

Joints of structural elements. Reasons of application. General requirements to joints. Joints classification by different features. Screw joints.

Attachment fittings of airplane units. Classification of attachment fittings. Point attachment fittings (fork-ear, comb, fitting). Contour attachment fittings (fitting, flange, with triangular doublers, ramrod, shear). Advantages and disadvantages of each type of attachment fittings.

TOPIC* 4** . ***Ailerons.

Application. Principle of operation. Parameters. Differential ailerons. Methods of yawing moment decreasing. Hinge moment compensation. Types of hinge moment compensation (axial, horn, inner aerodynamic, servo-compensator, servo-rudder, trimmer, flettner). Weight balancing of ailerons.

Wing mechanization. Application. Parameters. Classification. Requirements. Aerodynamic means of wing trailing edge mechanization (spoilers, flaps, flaperons, hanging ailerons). Principle of operation, structural distinctions. Aerodynamic means of wing leading edge mechanization (front flaps, nose inclining flaps, spoilers). Principle of operation, structural distinctions. Adaptive wing. Energy means of mechanization (Coand effect, removing of boundary layer, exhausting of boundary layer, reactive flap). Combine means of mechanization. Aerodynamic characteristics of wing at application of mechanization means. Distinctions of mechanization means attachment.

Means of wing stall characteristics increasing. Requirements to them. Types of mentioned means (wing geometrical twisting, wing aerodynamic twisting, edge front flap, aerodynamic horns, interceptors, dampers of lifting force). Their design.

TOPIC 5. Airplane control surfaces.

Control surface design. Requirements. Parameters. Operational principle. Horizontal control surface (HCS). HCS coefficient of static moment. Whole-rotating stabilizer (reasons of application, load-carrying scheme of whole-rotating HCS, structural distinctions). Shifting stabilizer (reasons of application, structural distinctions). Vertical control surface (VCS). VCS coefficient of static moment. Twin keel VCS. Fore keel. False keel. Rudder surfaces. Geometrical parameters of rudder surfaces. Loading on control surface. Arrangement of control surface. Advantages and disadvantages of arrangement schemes. «V»-shape control surface. Control surface design.

TOPIC* 6** . ***Fuselage. Landing gear.

Fuselage. Application. Requirements. Outer shapes. «Rule of sections». Parameters. Loading on fuselage. Fuselage load-carrying schemes (with spars, semi-monocoque, monocoque). Spars, stringers, frames (normal (ordinary), reinforced), fuselage skin. Fuselage cabins. Requirements to cabins. Air-tight cabins (ventilation, regeneration). Crew cabins. Passenger cabins. Emergency-rescue equipment.

Landing gear. Application. Arrangement. Requirements. Parameters. Arrangement schemes of landing gear (triple-supporting with tail Arrangement, triple-supporting with nose support, double-supporting). Advantages and disadvantages of each arrangement scheme. Loading to landing gear. Main parts of landing gear strut. Load-carrying schemes of gear struts (truss, beam, beams with struts). Schems of struts releasing and retraction. Types of attachments of wheel on strut (telescopic, semi-lever, lever with embedded damper, lever with outer damper, lever without strut). Distinctions of landing gear struts design. Dampers. Application, requirements, arrangement. Scheme and principle of operation of liquid-gas damper (LGD). Diagram of LGD operation. Liquid damper (LD). Diagram of LD operation.

TOPIC* 7. *Control systems of airplanes.

Application. Requirements. Arrangement. Classification of control systems by different criteria. Command levers (hand, leg). Control system wiring (rigid, flexible, combined). Types of control systems. Direct control systems. Indirect control systems. Reversed control systems. Irreversible control systems. Reasons of application. Arrangement (loading mechanism, non-linear mechanism, mechanism for transmission ration changing, mechanism of trimmer effect, expanding rods, mechanism for prevention of airplane reaching of out-of-operational overloading). Distinctions of ailerons and elevons control.

TOPIC* 8. *Aeroelasticity

Types of aeroelasticity. Divergency. Reversing of control surfaces. Ailerons floating. Transonic oscillations of control surfaces. Bending-aileron flutter. Bending-twisting flutter. Distinctions of control surface flutter. Panel flutter. Buffeting. Influence parameters of wing on aeroelastic characteristics. Structural means for improving airplane anti-flutter characteristics.

Modular control

Substantial module № 2 General arrangement of helicopters

TOPIC 9. Загальна характеристика вертольоту.

Principles of flight and helicopter arrangement. Helicopter properties. Helicopter schemes. Positive properties and disadvantages of arrangement schemes.

Main requirements to helicopters. External view of up-to-date helicopters of different schemes and their main units. General characteristics of helicopter units.

Main purpose and functions of main rotor. Requirements to main rotors. Main geometrical and kinematic parameters. Physical picture of main rotor operation in regime of hanging, vertical takin-off and oblique flowing. Blades swinging motion. Blades oscillations in plane of rotation. Horizontal, vertical and axial hinges of rotor. Critical zones of main rotor flowing.

TOPIC 10. Different types of hubs for main and control rotors.

Types of main rotors. Types of hubs. Purpose of a hub with extended horizontal and vertical hinges. Structural parameters of hub. Loading on hub. Main hub elements. Design of hub case, horizontal, vertical and axial hinges, intermediate chains. Joining of hub case with shaft of main reduction gear. Restrictors of blade swinging motions and oscillations. Out-of-center restrictor of blade hanging.

Dampers of vertical hinges, their characteristics. Notion of earth resonance. Lever of blade rotation. Compensator of blade stoke. Hubs with typical horizontal and vertical hinges. Hubs with common horizontal hinge. Their distinctions. Metal-fluoride plastic sliding bearings.

Hubs of main rotors on cardan. Structural distinctions. Advantages and disadvantages. Hubs with rigid or semi-rigid attachment to rotor. Structural distinctions. Advantages and disadvantages.

Hubs of main rotor with elastomer bearings. Design of elastomer bearing. Advantages and disadvantages of elastomer bearings. Types of elastomer bearings. Design of axial hinge with torsion. Materials recommended for different hub elements. Main rotors hubs maid of composites.

TOPIC* 11. *Different types of blades for main and control rotors.

Blade main geometrical parameters. Types of airfoils used for blades. Blade twisting. Blade surface. Blade weight and load-carrying arrangement. Loads to blade. Blade rigidity. Blade flatter. Load-carrying schemes of blades: whole-metal blade structure, blade made of composites, combined structures.

Blain arrangement. Design of whole-metal blades with tubular spar. Method of spar dynamic strength increasing. Design of blade with pressed spar. Design of blade made of composites. Blade protection from erosion wear and icing. Methods of ensuring fault tolerance for main rotor blade structural elements. Arrangement of signaling system of spar damaging.

Tail rotor types and application. Requirements to them. Distinctions of loading of tail rotors of different types. Load-carrying scheme of blades. Design of tail rotor hub. Tail rotors of “Fenestron” type. Technical and operational advantages of tail rotors of “Fenestron” type. Distinctions and design of “Fenestron” rotor, X – shape control rotors. Their advantages and disadvantages.

TOPIC 12. General characteristic of helicopter control

Types of helicopter control. Arrangement of control system. Requirements to helicopter control. Characteristics of helicopter control: efficiency, sensitivity, powerfulness and delaying of control. Forces on command levers. Independence of control. Schemes that guarantee independence of control.

Classification by application and type of wiring. Manual control. Arrangement of manual control.

Schemes of longitudinal and lateral control of helicopter. Control of common step (spacing) of main rotor, engines and stabilizer. Schemes of control. Leg control. Arrangement of leg control. Schemes of heading control. Control wiring. Drawbacks of flexible wiring. Transmission brake control.

Scheme of forces appearing in main rotor control system. Permanent and periodical types of forces in controlling. Dampers in control wiring. Values of forces in control of helicopters of different weight categories. Arrangement and operational scheme of mechanisms of loading and unloading. Characteristic of hydro-buster loading.

Swashplate. Application, operational principle and design. Types of swashplates. Schemes of control leading.

Application and requirements to transmissions. Arrangement of transmissions. Objective of main units of transmission. Principal schemes of transmissions of different helicopters. Advantages and disadvantages. Distinctive structural features of main reduction unit transmissions in single-rotor helicopters of different weight grades. Restrictions on power that is transmitted by reduction unit conical pairs of gears. Loading on transmission elements.

Requirements to reduction gears, shafts, their joints (slot and elastic clutch, cardan), shaft supports, free rotating clutches, brakes of main rotor, under reduction gear frame. Types of main reduction gears, their design. Design of intermediate and tail reduction gears, shafts, their joints, free rotating clutches, under reduction gear frame. Ways for helicopter transmission perfection.

TOPIC 13. Unmanned arial vehicles (UAV).

UAV application. Classification. UAV of helicopter type. Characteristics, parameters.

UAV of airplane type. Characteristics, parameters. Perspectives of UAV development.

Modular control

5. Arrangement of the discipline

Titles of modules and topics	Hrs				
	Total	Including			
		lec	pr	lab	ind
1	2	3	4	5	6
Substantial module № 1. General arrangement of airplanes					
TOPIC* 1. *Introduction. Airplanes classification. General requirements to airplane structure. Variability of designing.	7	2	2		3
TOPIC 2 Wings. Wing shapes. Wing loading. Longitudinal and lateral members. Wing load-carrying schemes. Rectangular wing. Arrow-like wing. Triangular wing. Field of application. Advantages, disadvantages. Arrangement of longitudinal and lateral members in triangular wings.	10	4	2		4
TOPIC 3 . Fastening elements. Joints. Attachment fittings.	8	4			4
TOPIC 4 . Ailerons. Wing mechanization. Aerodynamic characteristics of wing at application of mechanization means. Distinctions of mechanization means attachments. Methods of wing stall characteristics increasing.	8	2	2		4
***TOPIC* 5**. Aircraft control surface.	10	4	2		4
TOPIC 6 . Fuselage. Landing gear.	7	4			3
TOPIC 7. Airplanes control systems.	5	2			3
TOPIC 8. Aeroelasticity.	5	2			3
Modular control контроль					

Total with substantial module 1	60	24	8		28
Substantial module № 2. General arrangement of helicopters					
TOPIC 9. General characteristic of helicopter.	14	6	2		6
TOPIC 10. Hubs of main and control rotors of different types.	12	4	2		6
TOPIC 11. Rotor blades of main control rotors of different types.	14	6	2		6
TOPIC 12. General characteristic of helicopter control	12	4	2		6
TOPIC 13. Unmanned arial vehicles (UAV)**.** Application. Classification. UAV of helicopter type. Characteristics, parameters. UAV of airplane type. Characteristics, parameters. Perspectives of UAV development.	8	4			4
Modular control					
Total with substantial module 2	60	24	8		28
Total hrs	120	48	16		56

6. Topic of seminars

№	Topics	Hrs
	Absent in the program	

7. Topic of practical classes

№	Topics	Hrs
1	Load-carrying schemes of wing.	2
2	Elements of wing arrangement.	2
3	Ailerons and wing mechanization. Airplane control.	2
4	Fuselage.	2
5	Control surfaces.	2
6	Helicopters schemes.	2
7	Blades of main and control rotors of different types	2
8	Hubs of main and control rotors of different types.	2
	Total	**16**

8. Topics of laboratory classes

№	Topics	Hrs
	Absent in the program	

9. Independent work

№	Topics	Hrs
1	Selection and analysis of statistic data of aircrafts based on given tactical-technical data (TTD).	4

2	Selection and grounding of aircraft aerodynamic scheme**.** Specifying TTD and design geometrical parameters.	4
3	Determination of aircraft take-off mass of zero approximation.	4
4	Determination main geometrical parameters of aircraft units (wing, control surfaces, fuselage, landing gear).	4
5	Making drawing of aircraft general view.	4
6	Aircrafts classification by application.	3
7	Aircrafts classification by range of flight.	3
8	Equation of aircraft existence.	3
9	Types of rotating wings.	3
10	Articulated wing. Geometry of wing mid-line.	3
11	General arrangement of rotating wings.	3
12	Method of aircraft drag elevation.	2
13	Loading on means of mechanization.	2
14	Front whole-rotative horizontal control surfaces (WRHCS).	2
15	Geodesic fuselages.	2
16	Distinctions of design of cargo airplanes.	2
17	Wings and control surfaces of helicopters.	2
18	Fuselage of helicopter.	2
19	UAV. Objectives. Classification. UAV of helicopter type. Characteristics, parameters.	2
20	Hydraulic systems of airplanes and helicopters.	2
	Total	**56**

10. Individual tasks

CGW «Development of aircraft (helicopter) take-off weight»

11. Teaching methods

Conduction of classroom lectures, practical classes, individual consultations (if necessary), independent student's work with materials published by department (methodological books), leading aviation companies, usage of Internet resources and electronic materials uploaded to department site, conduction of the first round of Major Olympiad.

12. Control methods контролю

Carrying out of current control, written modular control, final control in the form of offset.

13. Evaluation criteria and distribution of points received by students

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

Components of educational work	Points for one lesson (task)	Number of lessons (tasks)	Total number of points
Substantial module 1			
Work on lectures	0…1	8	0…8
Execution and protection of (practical) works	0...3	4	0...12
Modular control	0…20	1	0…20
Total for module 1			**0…40**
Substantial module 2			
Work on lectures	0…1	8	0…8
Execution and protection of (practical) works	0...3	4	0...12
Modular control	0…20	1	0...20
Total for module 1			**0…40**

Calculation-graphical work (CGW)	**0…20**
Total	**0...100**

Semester control (test) is conducted in case, if student is not agree with the level score he/she have got and at presence of CGW/practical tasks fully fulfilled. During test conduction student have the right to get maximum score level - 100 points.

13.2. Qualitative evaluation criteria

The required amount of knowledge to obtain a positive assessment:

– advantages and disadvantages of helicopter aircraft of different layout schemes;

– purpose and general design of the main systems and units of aircraft;

– rational areas of application of various structural and power schemes of units;

– methods and means of improving the take-off and landing characteristics of aircraft and;

– methods and means of improving the airtightness characteristics of aircraft ;

– advantages and disadvantages of different engine layout options for aircraft and– structure and composition of onboard systems and equipment of aircraft.

The required amount of skills to obtain a positive assessment:

• analyze the requirements for the main units of aircraft and helicopters to determine the general ways of their satisfaction;

• perform sketches of elements and components of real structures;

• determine the design and power schemes of real units of aircraft structures

• perform drawings of CLS units

• perform schemes of power binding of aircraft units

• perform drawings of CLS LA as a whole.

• perform drawings of the aircraft as a whole.

13.3 **Criteria for evaluating student work during the semester**

Excellent (90 - 100). Assimilate and perform the above. Additionally, know the advantages and disadvantages of various structural and power schemes (CSS) of the main components of the aircraft and helicopter. Be able to analyze the impact of different (LCS) on the flight and tactical and technical characteristics of the aircraft by different criteria (aerodynamic, minimum weight, manufacture, resource, operation, economic performance). Navigate in textbooks and manuals.

Good (75 - 89). Assimilate and perform the above. Additionally, know the various structural and power schemes of the main components of the aircraft

Satisfactory (60-74). Have a minimum of knowledge and skills. Work out and defend all practical and calculation-graphic works. Know the components of the aircraft, their purpose and general structure. Determine the basic parameters of the parts of the aircraft in the zero approximation. Develop a general view of the aircraft and make its drawings. Develop structural and power schemes of aircraft units and their power connection.

Estimation scale: by score points and national

Total score points	Mark by national scale	
	Exam, differentiated test	Pass
90 – 100	Excellent	Passed
75 – 89	Good	
60 – 74	Satisfactorily	
0 – 59	Unsatisfactorily	Not passed

14. Methodical support

Department lecture notes and literature sources (hard and electronic copies) located in department library.

1. Единые нормы летной годности гражданских самолетов. – М.: Машиностроение, 1985. 470 с.
2. Кривцов В.С., Карпов Я.С., Федотов М.М. Інженерні основи функціонування і загальна будова аерокосмічної техніки. Харків, ХАІ, 2002. Ч. 1 – 468 с, Ч. 2 – 723 с.
3. Кривцов В.С., Карпов Я.С., Федотов М.Н. Основы аэрокосмической техники. Х., ХАИ, 2003. Ч. 1 - 620 с, Ч. 2 - 901 с
4. Основные положения воздушного кодекса Украины и норм летной годности самолетов транспортной категории. – Учебн. пособие/ Е. Т. Василевский, В. А. Гребеников, В. Н. Николаенко. – Харьков: Нац. аэрокосм. ун-т «Харьк. авиац. ин-т», 2006. – 332 с.
5. Конструкция самолетов и вертолетов: - учебник / В. С. Кривцов, Л. А. Малашенко, В. Л. Малашенко, С. В. Трубаев. – Х.: Нац. аэрокосм. ун-т «Харьк. авиац. ин-т», 2010. – 366 с.
6. Конструкция самолетов и вертолетов / Л. А. Малашенко, Л. В. Капитанова. – Учебное пособие по лабораторному практикуму. – Харьков: Нац. аэрокосм. ун-т «Харьк. авиац. ин-т», 2006. – 71 с.

15. Recommended literature

Main:

1. Бельский В.Л.,.Власов И.П., Зайцев В.Н.и др. Конструкция летательных аппаратов., М, Оборонгиз, 1963, 709 с.
2. Глаголев А.Н., Гольдинов М.Я., Григоренко С.М., Конструкция самолетов, М, Маш-е, 1975, 480с.
3. Зайцев В.Н., Рудаков. В.Л. Конструкция и прочность самолетов. — Киев, Вища школа, 1976. 487 с.
4. Житомирский Г.И., Конструкция самолетов, М, Маш - е, 1995, 416с
5. Проектирование самолетов, С.М.Егер, В.Ф.Мишин, Н.К.Лисейцев и др., М., Маш-е, 1983, 616 с.
6. Шульженко М.Н., Конструкция самолетов, М, Маш - е, 1971, 412с
7. Федотов, М. Н. Основы конструирования элементов аэрокосмической техники [Текст] : учебник : в 3 ч. / М. Н. Федотов. – Харьков : Нац. аэрокосм. ун-т им. Н. Е. Жуковского «Харьков. авиац. ин-т», 2019. – Ч. 3, т. 4. – 640 с.
8. Ружицкий Е.И. Альбом конструкций втулок несущих винтов вертолетов. Пособие для курсового и дипломного проектирования. - М.: МАИ, 1980. -38 с.
9. Богданов Ю.С. и др. Конструкция вертолетов. - М.: Машиностроение, 1990. -272 с.
10. Механические передачи вертолетов, под ред. В.Н. Кестельмана. -М.: Машиностроение, 1983. - 120 с.
11. Далин В.Н., Михеев С.В. Конструкция вертолетов: Учебник. – М.: МАИ, 2001.– 352с.

Auxiliary:

1. Арсон Л.Д., Рябков В.И., Кобылянский А.А. Проектирование узлов крыла. Харьков:, 1969, 32 с.
2. Арсон Л.Д., Лебединский А.Г. Редько А.А. Проектирование силовых шпангоутов (уч. пособие). — Харьков: ХАИ, 1978, 44 с.
3. Гребеньков О.А. Конструкция самолетов. — М.: Машиностроение, 1984, 240 с.
4. Гребеников А.Г., Арсон Л.Д. Вопросы проектирования срезных болтовых соединений крыла с учетом выносливости. – Харьков: ХАИ,1981. 112 с.
5. Гайдачук В.Е., Карпов Я.С. и др. Проектирование соединений элементов конструкции л.а. из (КМ). - Харьков: ХАИ, 1983, 103 с.
6. Зайцев В.Н., Рудаков. В.Л. Конструкция и прочность самолетов. — Киев,
7. Вища школа, 1976. 487 с.
8. Федотов М.Н. Конструирование соединений элементов самолетных конструкций (уч. пособие). Харьков: ХАИ, 1973. 72 с.

16. Information resources

1. Site of the Department of Airplanes and Helicopters Design.
2. Server of the Department of Airplanes and Helicopters Design.
3. Internet resources
4. https://mentor.khai.edu