Ministry of Education and Science of Ukraine
National Aerospace University
"Kharkiv Aviation Institute"

Department *Aircraft Engine Design* (No. *203*)

APPROVED

Chairman of the ScMC #1

(signature) *Serhii NYZHNYK* (first and last name)

" *30* " *08* 2023

SYLLABUS OF A *SELECTIVE* ACADEMIC DISCIPLINE

Engines of Airplanes and Helicopters

(academic discipline)

Discipline of individual choice 1

Field of education	*13 Mechanical Engineering; 14 Electrical engineering; 27 Transport* (code and name of a field of education)
Field of study	*131 Applied Mechanics; 133 Industrial Machinery Engineering; 134 Aerospace Engineering; 141 Power Engineering, Electrical Engineering and Mechanics; 142 Power Engineering; 272 Aviation Transport; 274 Automobile Transport* (code and name of field of study)
Educational program	*Design, Operational Diagnostics, Maintenance and Repair of Aircraft Engines and Power Plants; Aircraft Designing; Maintenance and Repair of Aircraft and Aviation Engines; Design, Manufacture and Certification of Aircraft; Design and Manufacturing of Composite Structures; Rocket and Space Complexes; Rocket-Space Engineering; Engineering Maintenance of Aircraft and Engines* (name of Educational program)

Form of study: full-time

Academic degree: *First (Bachelor)* (academic degree)

Kharkiv 2023

Person, who developed the syllabus — *Serhii SYKHOVII, Assoc. Prof., PhD* (author, position, academic degree and rank) — (signature)

The syllabus was approved at the meeting of the department
Aircraft Engine Design (No. 203)
(department)

Minutes No. *1* dated *" 28 "* *August* 2023.

Head of the department — *DSc., Professor* (academic degree and rank) — (signature) — *Serhii YEPIFANOV* (first and last name)

1. Description of the discipline

<table>
<tr><td>Characteristics</td><td>Branch of science, specialization, academic degree</td><td>Description of the discipline (full-time tuition)</td></tr>
<tr><td>Credits – 5</td><td>Field of education:
13 Mechanical Engineering;
14 Electrical engineering;
27 Transport
(cipher and name)</td><td>Selective</td></tr>
<tr><td>Modules – 3</td><td rowspan="5">Field of study:
131 Applied Mechanics;
133 Industrial Machinery Engineering; 134 Aerospace Engineering; 141 Power Engineering, Electrical Engineering and Mechanics;
142 Power Engineering;
272 Aviation Transport;
274 Automobile Transport
(cipher and name)</td><td>Academic year</td></tr>
<tr><td>Semantic modules – 3</td><td>2023 / 2024</td></tr>
<tr><td>Individual research task
unavailable
(title)</td><td rowspan="2">Semester</td></tr>
<tr><td>Total number of academic hours – 64*/150</td></tr>
<tr><td>Number of academic hours for full-time tuition:
auditorium – 4
independent work – 5,375</td><td rowspan="2">Educational program:
Design, Operational Diagnostics, Maintenance and Repair of Aircraft Engines and Power Plants; Aircraft Designing; Maintenance and Repair of Aircraft and Aviation Engines; Design, Manufacture and Certification of Aircraft; Design and Manufacturing of Composite Structures; Rocket and Space Complexes; Rocket-Space Engineering; Engineering Maintenance of Aircraft and Engines
(cipher and name)

Higher education:
First (Bachelor)</td><td>6-th</td></tr>
<tr><td>Lectures [1)]</td></tr>
<tr><td></td><td>32 a.h.</td></tr>
<tr><td></td><td>Practices, seminars [1)]</td></tr>
<tr><td></td><td>32 a.h.</td></tr>
<tr><td></td><td>Laboratory activities [1)]</td></tr>
<tr><td></td><td>–</td></tr>
<tr><td></td><td>Independent work</td></tr>
<tr><td></td><td>86 a.h.</td></tr>
<tr><td></td><td>Form of examination</td></tr>
<tr><td></td><td>Modular control, exam</td></tr>
</table>

The ratio of hours of classes to independent work is: for full-time education - 64 / 86.

[1)] *Auditory load can be reduced or increased by one hour, depending on the schedule of classes.*

2. Goals and purposes of discipline

Goal: provide the necessary knowledge on the use of aircraft engines and helicopters.
Task: study of parameters and characteristics of aircraft and helicopter engines.

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

General competencies: Knowledge and understanding of the subject area and understanding of professional activity. Ability to abstract thinking, analysis and synthesis.

Special (professional) competencies: The use of mathematical apparatus in solving problems in the field of design and manufacture of structures. 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 basic: sections of physics, mechanics, electrostatics, electrodynamics, optics, aerohydrodynamics. Ability to calculate elements of aerospace and rocket technology, including composite materials using knowledge in the field of mechanics and strength of materials and structures. Design the main structural elements of aerospace technics (spars, skin, ribs, etc.). Ability to use appropriate software (programming languages, packages) for physical and mathematical calculations in the field of design and manufacture of aircraft structures.

Program learning outcomes: Ability to think mathematically and logically, knowledge of basic concepts, ideas and methods of fundamental mathematics and the ability to use them in solving specific problems. Assessment of modern processes and problems of social development from the standpoint of the natural science nature of society. Describe experimental methods for studying the structural, physico-mechanical and technological properties of materials, as well as non-destructive methods of quality control.

Interdisciplinary sounds: engineering basics of aerospace technology, introduction to the specialty, theoretical mechanics, mechanics of materials and structures, basics of aerospace engineering design, theory of aerojet engines, basics of design of aircraft engines and power plants.

3. Course content

Module 1

TOPIC 1. Subject and tasks of the course. Its place in educational plan. Bibliography. Composition of aircraft power plant. Classification of aero engines. Main parameters of aircraft engines. Requirements to GTE. Advantages and disadvantages of different engines. Requirements to engines of different purpose, airworthiness requirements (АП-33, FAR).

TOPIC 2. GTE as combination of heat machine and propulsor. Thermodynamic cycle of GTE. Formula for specific work of thermodynamic cycle. Influence of engine parameters on specific work and specific power. Efficiency of thermodynamic cycle, its relation with work and dependence on influencing parameters. Specific fuel consumption of turboshaft engine and its relation with efficiency.

TOPIC 3. Specifics of turbojet engine working process. Formula of thrust. Specific thrust and its relation with work of cycle. Influence of engine parameters and flight condition on specific thrust. Specific fuel consumption, its dependence on turbine inlet temperature and compressor pressure ratio.

TOPIC 4. Specifics of turboprop engine working process. Optimal distribution of cycle work between propeller and jet nozzle. Turbofan engines; influence of engine parameters on specific thrust and specific fuel consumption. Main advantages of turbofan engines to single-flow ones.

TOPIC 5. Compressors: classification (axial, centrifugal and combined). Area of centrifugal compressors application. Composition of axial compressor stage and bases of its operation. Euler's formula for work of elementary stage. Function of inlet guide vanes. Unstable operational modes, surge. Constructive methods of compressor stability improving. Multistage compressor performance compressor map).

TOPIC 6. Turbines: composition and bases of turbine stage operational process. Turbine cooling.

TOPIC 7. Combustion chambers. Composition of atmospheric air. Requirements to fuel, its main parameters: heat capacity, density, evaporability. Fuel composition, standard hydrocarbon fuel. Characteristic features of combustion as chemical reaction: velocity of flame propagation, stechiometric ratio, flame temperature, ranges of stable combustion and ignition. Constructive solution of main problems of combustion: air velocity decreasing, combustion zone separation, fuel supplying, flame stabilizing, mixing flows, inflaming.

TOPIC 8. Engine operational modes: maximal, maximal durable, cruise, flight and on-ground idle, emergency, reversal. Engine partial-load performance. Engine parameters correction for flight conditions taking into account. Bases of engine automatic control. Programs of control. Engine climatic, altitude and velocity performances.

Module 2

TOPIC 9. Coordination of engine performances with airplane in takeoff conditions. Interrupted and continued takeoff. Required takeoff thrust. Conditions for interrupted takeoff. Means for takeoff distance shortening. Steady-state and transient modes. Engine acceleration. Full and partial acceleration. Acceleration time determination. Engine deceleration. Deceleration time determination. Variation of engine parameters during acceleration and deceleration.

TOPIC 10. Coordination of engine performances with airplane in cruise conditions. Forces equilibrium in horizontal flight and its variation during long-term flight taking into account fuel depletion. Required cruise thrust. Coordination of engine performances with airplane in landing conditions. Required reverse thrust determination. Means for landing distance shortening. Specifics of coordination engine performances with helicopter performances.

TOPIC 11. Main units and power schemes of GTEs. Operational conditions and loads acting main engine units and components. Gas forces and moments acting engine units. Inertial forces acting engine units. Sources of thermal stresses in engine units and components. Power systems of rotors and stators. Engine mounting units.

TOPIC 12. Compressors structure. Functions, operational conditions and requirements to compressors. Classification of compressors, their comparative analysis. Axial and centrifugal compressors. Constructive schemes of axial compressors. Requirements to compressor construction and their realization. Types of axial compressors rotors, their comparative analysis. Compressor rotor blades and their mounting units. Loads acting compressor rotor. Compressor stators. Clearances between rotor and stator. Sealing of compressor gas path. Methods to provide compressor stable operation. Compressor constructive materials.

TOPIC 13. Turbines structure. Functions, operational conditions and requirements to turbines. Parameters which characterize turbine perfection. Turbine rotor blades, methods of their attaching to disc. Turbine discs, their junction between themselves and to shaft. Turbine stators. Nozzle box: operational conditions, power scheme, methods of fixing. Turbine casings. Cooling of turbine components. Clearances between rotor and stator. Turbine constructive materials.

TOPIC 14. Engine rotor systems and shaftings. Rotors static and dynamic balancing. Methods to decrease axial forces acting engine rotors. Rotor supports displacement. Engine shafting, couplings construction. Supports construction. Elastic-damper supports.

TOPIC 15. Exhaust systems and thrust reversal. Exhaust systems: functions, operational conditions, requirements. Exhaust tubes. Types of jet nozzles. Controlled and non-controlled nozzles. Nozzles heat isolation and cooling. Thrust reversals and thrust deviators. Power plant as a source of noise and vibration. Constructive methods of noise suppression.

Module 3

TOPIC 16. Systems of aircraft engine. Fuel supply system. Operational conditions and requirements to a system. Schemes of systems. Main elements.

TOPIC 17. Lubrication systems. Specific features of lubrication systems for THE, TFE, TPE and helicopter TShE. Aggregates of lubrication systems. Lubrication materials.

TOPIC 18. Starting systems. Requirements to starting system. Types of starters. Starting sequence diagram.

TOPIC 19. Engine automatic control and automated diagnosing systems. Structure and main elements of GTE ACS. Programs and laws of control. ACS quality indexes. Engine diagnosing tasks. On-board and on-ground diagnosing systems.

TOPIC 20. Engine ice-protection systems. Components which need ice protection. Flight conditions of icing origination. Types of systems.

4. Course arrangement

Names of Modules and Topics	Number of hours				
	full-time tuition				
	total	namely			
		lec	lab	pr	i.w.
1	2	3	4	5	6
SEMESTER 6 Module 1					
TOPIC 1. Subject and tasks of the course. Its place in educational plan. Bibliography. Composition of aircraft power plant. Classification of aero engines. Main parameters of aircraft engines. Requirements to GTE. Advantages and disadvantages of different engines. Requirements to engines of different purpose, airworthiness requirements (АП-33, FAR).	8	2	-	2	4
TOPIC 2. GTE as combination of heat machine and propulsor. Thermodynamic cycle of GTE. Formula for specific work of thermodynamic cycle. Influence of engine parameters on specific work and specific power. Efficiency of thermodynamic cycle, its relation with work and dependence on influencing parameters. Specific fuel consumption of turboshaft engine and its relation with efficiency.	6	2	-	-	4
TOPIC 3. Specifics of turbojet engine working process. Formula of thrust. Specific thrust and its relation with work of cycle. Influence of engine parameters and flight condition on specific thrust. Specific fuel consumption, its dependence on turbine inlet temperature and compressor pressure ratio.	6	2	-	-	4
TOPIC 4. Specifics of turboprop engine working process. Optimal distribution of cycle work between propeller and jet nozzle. Turbofan engines; influence of engine parameters on specific thrust and specific fuel consumption. Main advantages of turbofan engines to single-flow ones.	5	1	-	-	4
TOPIC 5. Compressors: classification (axial, centrifugal and combined). Area of centrifugal compressors application. Composition of axial compressor stage and bases of its operation. Euler's formula for work of elementary stage. Function of inlet guide vanes. Unstable operational modes, surge. Constructive methods of compressor stability improving. Multistage compressor performance compressor map).	7	1	-	2	4
TOPIC 6. Turbines: composition and bases of turbine stage operational process. Turbine cooling.	6	2	-	-	4
TOPIC 7. Combustion chambers. Composition of atmospheric air. Requirements to fuel, its main parameters: heat capacity, density, evaporability. Fuel composition, standard hydrocarbon fuel. Characteristic features of combustion as chemical reaction: velocity of flame propagation, stechiometric ratio, flame temperature, ranges of stable combustion and ignition. Constructive solution of main problems of combustion: air velocity decreasing, combustion zone separation, fuel supplying, flame stabilizing, mixing flows, inflaming.	8	1	-	3	4
TOPIC 8. Engine operational modes: maximal, maximal durable, cruise, flight and on-ground idle, emergency, reversal. Engine partial-load performance. Engine parameters correction for flight conditions taking into account. Bases of engine automatic control. Programs of control. Engine climatic, altitude and velocity performances.	6	1	-	3	2
Totally	**52**	**12**	**-**	**10**	**30**

Module 2					
TOPIC 9. Coordination of engine performances with airplane in takeoff conditions. Interrupted and continued takeoff. Required takeoff thrust. Conditions for interrupted takeoff. Means for takeoff distance shortening. Steady-state and transient modes. Engine acceleration. Full and partial acceleration. Acceleration time determination. Engine deceleration. Deceleration time determination. Variation of engine parameters during acceleration and deceleration.	11	3	-	2	6
TOPIC 10. Coordination of engine performances with airplane in cruise conditions. Forces equilibrium in horizontal flight and its variation during long-term flight taking into account fuel depletion. Required cruise thrust. Coordination of engine performances with airplane in landing conditions. Required reverse thrust determination. Means for landing distance shortening. Specifics of coordination engine performances with helicopter performances.	9	3	-	2	4
TOPIC 11. Main units and power schemes of GTEs. Operational conditions and loads acting main engine units and components. Gas forces and moments acting engine units. Inertial forces acting engine units. Sources of thermal stresses in engine units and components. Power systems of rotors and stators. Engine mounting units.	8	4	-	-	4
TOPIC 12. Compressors structure. Functions, operational conditions and requirements to compressors. Classification of compressors, their comparative analysis. Axial and centrifugal compressors. Constructive schemes of axial compressors. Requirements to compressor construction and their realization. Types of axial compressors rotors, their comparative analysis. Compressor rotor blades and their mounting units. Loads acting compressor rotor. Compressor stators. Clearances between rotor and stator. Sealing of compressor gas path. Methods to provide compressor stable operation. Compressor constructive materials.	6	-	-	2	4
TOPIC 13. Turbines structure. Functions, operational conditions and requirements to turbines. Parameters which characterize turbine perfection. Turbine rotor blades, methods of their attaching to disc. Turbine discs, their junction between themselves and to shaft. Turbine stators. Nozzle box: operational conditions, power scheme, methods of fixing. Turbine casings. Cooling of turbine components. Clearances between rotor and stator. Turbine constructive materials.	6	-	-	2	4
TOPIC 14. Engine rotor systems and shaftings. Rotors static and dynamic balancing. Methods to decrease axial forces acting engine rotors. Rotor supports displacement. Engine shafting, couplings construction. Supports construction. Elastic-damper supports.	6	-	-	2	4
TOPIC 15. Exhaust systems and thrust reversal. Exhaust systems: functions, operational conditions, requirements. Exhaust tubes. Types of jet nozzles. Controlled and non-controlled nozzles. Nozzles heat isolation and cooling. Thrust reversals and thrust deviators. Power plant as a source of noise and vibration. Constructive methods of noise suppression.	6	-	-	2	4
Totally	**52**	**10**	**-**	**12**	**30**
Module 3					
TOPIC 16. Systems of aircraft engine. Fuel supply system. Operational conditions and requirements to a system. Schemes of systems. Main elements.	13	4	-	4	5
TOPIC 17. Lubrication systems. Specific features of lubrication systems for THE, TFE, TPE and helicopter TShE. Aggregates of lubrication systems. Lubrication materials.	12	3	-	4	5
TOPIC 18. Starting systems. Requirements to starting system. Types of starters. Starting sequence diagram.	8	3	-	-	5
TOPIC 19. Engine automatic control and automated diagnosing systems. Structure and main elements of GTE ACS. Programs and laws of control. ACS quality indexes. Engine diagnosing tasks. On-board and on-ground diagnosing systems.	8	-	-	2	6

TOPIC 20. Engine ice-protection systems. Components which need ice protection. Flight conditions of icing origination. Types of systems.	5	-	-	-	5
Totally	**46**	**10**	**-**	**10**	**26**
Totally for course	**150**	**32**	**-**	**32**	**86**

5. Practical activities

No.	Topic	Hours
1	General learning construction of TJE, ATJE, TPE, TShE, TFE, of different generations which are presented in department. Arrangement schemes	3
2	Construction of compressors	3
3	Combustion chambers	3
4	Engine operational modes and coordination of engine performances	3
5	Compressors structure.	3
6	Turbines structure	3
7	Engine rotor systems. Shaftings of aircraft GTE	3
8	Exhaust systems and thrust reversers	3
9	Fuel supply system	3
10	Lubrication system	3
11	Engine automatic control and automated diagnosing systems.	2
	Total	**32**

6. Individual work

No.	Topic	Hours
1	Bases of engine thermodynamic analysis	6
2	Thrust and power generation	6
3	Principles of blade machines operation	6
4	Combustion chambers	6
5	Engine performances	6
6	Engine coordination with aircraft	6
7	Compressors	6
8	Turbines	6
9	Shaftings	6
10	Exhaust systems and thrust reversers	6
11	Fuel supply systems	6
12	Lubrication systems	5
13	Starting systems	5
14	Engine automatic control and automated diagnosing systems	5
15	Engine ice-protection systems	5
	Total	**86**

7. Learning methods

Basic forms of education:
- lecture;
- laboratory work;
- individual independent work of the student;
- exam.

At the lecture the student is given the basic concepts, basics of theory, patterns necessary to prepare for laboratory work, independent work. The lecture solves only one didactic task - gives the initial

acquaintance with the topic, organizes the initial perception of the material, formulates the main problems.

Carrying out of laboratory works is based on the verbal (analytical) description of object (engine or knot) and on its material display by means of special didactic materials (cut models, posters, laboratory equipment, etc.). During the laboratory work the team nature of students' work is used.

The main form of education is independent work. It cannot be started without a certain baggage of knowledge given in lectures. During independent work, students study the lecture material in depth, prepare for laboratory work.

Questions for independent work

Modulus 1

1. Classification of heat engines. Areas of different engine types application.
2. Scheme and operational principle of air-breathing engines.
3. Generations in engines development. Classification of engines by construction arrangement.
4. Thrust of turbojet engine. Formula of thrust at design mode. Main specific and integral parameters of turbine engine.
5. Composition of aircraft power plant.
6. Thermodynamic cycles of different types of turbine engines.
7. Work of turbine engine thermodynamic cycle. Influence of flight conditions and main thermodynamic parameters on work of thermodynamic cycle.
8. Specific thrust and specific fuel consumption for turbine engines of different types. Their dependence on flight condition and main thermodynamic parameters.
9. Working process in inlet device.
10. Working process in compressor stage. Velocity triangles in different stations of stage. Factors limiting work and pressure ratio of compressor stage.
11. Function of compressor inlet guide vanes.
12. Compressor map of multistage compressor.
13. Unstable operational modes of compressor. Surge.
14. Working process of combustion chamber. Air/fuel ratio and its influence on combustion stability.
15. Working process in turbine stage. Velocity triangles in different stations of turbine stage.
16. Working process of jet nozzle. Laval nozzle.
17. Engine characteristic operational modes.
18. Partial-load performances of turbojet and turboprop engines. Output (external) performance of turboshaft engine.
19. Altitude, velocity and climatic performances.

Modulus 2

20. Coordination of engine and airplane in takeoff conditions.
21. Coordination of engine and airplane in cruise conditions.
22. Coordination of engine and airplane in landing conditions.
23. Coordination of engine and helicopter performances.
24. Forces and moments acting engine components.
25. Power schemes of engine rotors and stators.
26. Engine mounting units.
27. Functions of compressor. Main constructive parameters.
28. Classification, comparative description and areas of application of different types of compressors.
29. Constructive schemes of axial compressors.
30. Construction of axial compressors rotors.
31. Compressor rotor blades, requirements to them. Fixation of rotor blades.

32. Loads acting rotor of axial compressor. Means for decreasing axial force acting radial-thrust bearing of compressor.
33. Structure of axial compressors stators.
34. Constructive means for compressor gas-dynamic stability improving.
35. Constructive materials used in compressors.
36. Functions and operational conditions of gas turbines. Requirements to construction of GTE turbine.
37. Constructive schemes and parameters of gas turbines.
38. Construction of turbine rotor blades and their fixing units.
39. Turbine discs, their joining between themselves and with shaft.
40. Construction of turbine stators.
41. Rotor blades and nozzle boxes cooling.
42. Turbine discs and casings cooling.
43. Constructive materials used in turbines.
44. Functions, operational conditions and requirements to combustion chambers.
45. Construction of main combustion chamber. Constructive materials.
46. Classification of main combustion chambers.
47. Functions and composition of engine exhaust system. Operational conditions and requirements to exhaust systems.
48. Construction of exhaust systems of turboprop and helicopter turboshaft engines.
49. Construction of fixed and variable subsonic nozzles.
50. Construction of supersonic variable nozzles. Driving mechanism synchronization.
51. Functions and construction of thrust reversers and thrust deviators.
52. Loads transmission by elements of engine power casing.
53. Power schemes of engine rotors. Loads acting rotor power scheme.
54. Construction of shafts and coupling junctions.
55. Construction of rotor supports. Elastic and elastic-dumper supports.

Modulus 3

56. Functions of fuel supply systems, requirements to them.
57. Scheme of afterburning engine fuel supply system, main elements and their functions.
58. Types of fuel pumps, their comparative analysis.
59. Operation of centrifugal fuel nozzle, determination of fuel consumption. Methods of fuel control.
60. Functions of lubrication system, requirements to lubrication systems. Types of used oils.
61. Scheme of circulation normal-closed-circuit lubrication system, main elements and their functions. Lines of lubrication system.
62. Operation of feed and scavenge gear pumps.
63. Functions of starting systems and requirements to them. Engine starting process.
64. Composition of engine starting system. Types of starters and their comparison.
65. Purpose and composition of the automatic engine control system.
66. Engine control programs and control laws.
67. Functions and composition of engine diagnosing system.
68. Functions of engine ice-protection system. Flight conditions favorable for icing. Engine components which need ice protection.
69. Types and operation of engine ice protection systems.

8. Methods of control

During the study of discipline, the following types of control are used: current, modular and semester. ECTS requirements must be met when applying control measures.

Current control is carried out on all types of training sessions. The main purpose of the current control is to provide feedback between the teacher and the students in the learning process, to check the

readiness of the students for the implementation of the following educational tasks, and to ensure the management of their learning motivation. The information obtained during the current control is used to correct methods and methods of training, as well as for the independent work of students. Current control is carried out in the form of oral questioning or written express control during conducting of training sessions, speeches of students at the discussion of questions at seminars, as well as in the form of computer testing. The results of the current control (current progress) are the main information during the conduct of the test (modular control) and are taken into account in determining the final score from this discipline.

Modular control of knowledge, skills, and skills of students is carried out after studying the logically completed part (content module) of the curriculum. Modular control is conducted in the form of oral questioning or testing. The results of module control are additional information during the offset and are taken into account when determining the final score from this discipline.

Semester control is conducted in the form of a score in the amount of study material defined by the work program of the discipline. The form of semester control is written.

9. Testing

The material of the discipline is divided into three content modules:

1. Power systems, compressors and turbines of gas turbine engines.

2. Main and afterburner combustion chambers, output devices, transmissions. Aircraft engine systems.

3. Oscillations of blades, disks, shafts and shells.

Assembling module 1 - in the 5th week (once), assembling module 2 - in the 10th week (once), assembling module 3 - in the 13th week (once). The student is allowed to take the modules provided that they perform all types of compulsory work provided for in the modules. Registration of laboratory works - in writing, defense - orally.

Semester 6 - *exam*.

10. Evaluation criteria and distribution of the points that the students get

10.1 Distribution of the points that the students get (quantitative evaluation criteria)

Components of educational work	Points for one lesson (task)		Number of lessons (tasks)		Total number of points	
	У	ІНУМ	У	ІНУМ	У	ІНУМ
Module **1** Content module **1**						
Work at lectures	0…1	0…1	6	6	0…6	0…6
Execution and defense of practical works	1…2	1…2	5	5	5…10	5…10
Modular testing	15…17	15…17	1	1	15…17	15…17
Module **2** Content module **2**						
Work at lectures	0…1	0…1	5	5	0…5	0…5
Execution and defense of practical works	1…2	1…2	6	6	6…12	6…12
Modular testing	14…16	14…16	1	1	14…16	14…16
Module **3** Content module **3**						
Work at lectures	0…1	0…1	5	5	0…5	0…5
Execution and defense of practical works	1…2	1…2	5	5	5…10	5…10
Modular testing	15…19	15…19	1	1	15…19	15…19
Total for the semester					**60…100**	**60…100**

Semester control (credit) is carried out in case of refusal of the student from points of current testing and in the presence of the admission to credit. Admission to the test is granted under the conditions of working off and passing all laboratory works. During the semester test the student has the opportunity to receive a maximum of 100 points.

The test ticket consists of three theoretical questions, which are divided as follows: the first question is content module 1; the second question - content module 2; the third question is the content module 3. The maximum number of points for the first question is 30, the second question is 40, and the third question is 30.

10.2 Qualitative evaluation criteria

In order to receive a positive assessment, a student must

know:

- the role and place of the engine in the design and construction of aircraft;
- the procedure for designing an aircraft engine and its tests;
- limiting the range of use of the aircraft with this type of engine;
- design of aircraft gas turbine engines of all types, which are intended for subsonic and supersonic aircraft, requirements for engines for various purposes, requirements of airworthiness standards, design of components of these engines and parts;
- loads (static and dynamic) acting on the elements of gas turbine engines and aircraft from the engine, structural materials used in engines, strength standards;
- purpose and operation of engine systems;
- coordination of aircraft and engine parameters.

be able:

- justify the choice of engine type for a particular aircraft;
- perform a comparative assessment of existing engine designs;
- to form the initial technical requirements for the development of the engine for a specific type of aircraft;
- take into account the loads acting on the aircraft from the engine.

10.3 Criteria for assessing student work during the semester

Satisfactory (60-74). Have the necessary minimum of knowledge and skills. Work out and defend all laboratory work. Pass all modules with a positive grade. Know the role and place of the engine in the design and construction of aircraft. Explain the procedure for designing an aircraft engine and conducting its tests. Explain the limitations of the range of use of an aircraft with this type of engine. Know the design of aviation gas turbine engines of all types, which are intended for subsonic and supersonic aircraft. Be able to justify the choice of engine type for a particular aircraft. Perform a comparative assessment of existing engine designs.

Good (75-89). Firmly master the minimum of knowledge and skills. Work out and defend all laboratory work. Pass all modules with a positive grade. Know the role and place of the engine in the design and construction of aircraft. Explain the procedure for designing an aircraft engine and conducting its tests. Explain the limitations of the range of use of an aircraft with this type of engine. Know the design of aviation gas turbine engines of all types, which are intended for subsonic and supersonic aircraft. Be able to justify the choice of engine type for a particular aircraft. Perform a comparative assessment of existing engine designs. Know and explain the requirements for engines for various purposes, the requirements of airworthiness standards, the design of the components of these engines and parts. Know and explain the loads (static and dynamic) that act on the elements of the gas turbine engine and the aircraft from the engine. Know the construction materials used in engines, strength standards. Know the purpose and operation of engine systems. Be able to take into account the loads acting on the aircraft from the engine.

Excellent (90-100). Firmly master the minimum of knowledge and skills. Work out and defend all laboratory work. Pass all modules with a positive grade. Know the role and place of the engine in the design and construction of aircraft. Explain the procedure for designing an aircraft engine and conducting its tests. Explain the limitations of the range of use of an aircraft with this type of engine. Know the design of aviation gas turbine engines of all types, which are intended for subsonic and supersonic aircraft. Be able to justify the choice of engine type for a particular aircraft. Perform a comparative

assessment of existing engine designs. Know and explain the requirements for engines for various purposes, the requirements of airworthiness standards, the design of the components of these engines and parts. Know and explain the loads (static and dynamic) that act on the elements of the gas turbine engine and the aircraft from the engine. Know the construction materials used in engines, strength standards. Know the purpose and operation of engine systems. Know the principles of matching the parameters of the aircraft and engine. Be able to take into account the loads acting on the aircraft from the engine. Be able to form the initial technical requirements for the development of the engine for a specific type of aircraft.

Provided that all types of compulsory work provided in the modules and 4 modules are completed, the student may receive an overall grade and not pass the test.

If a student does not agree with the received rating, he can improve it during the test. The total modular grade is translated into a state trimester grade according to the recommended translation scale.

Grade scales: national and ECTS

Grade scale	National scale	
	For exam, course project (work), practice	For test
90-100	"excellent"	Passed
75-89	"good"	
60-74	"satisfactory"	
0-59	"non-satisfactory"	Not passed

11. Methodological support

1. Power point presentations, posters, e.t.c;
2. Mockups of TJEs, TFEs, TPEs, TShEs;
3. Tutorials for different topics of the course.

12. Recommended literature for the course

Main

1. Yepifanov, S. Major units of aircraft gas turbine engines: Tutorial [Text] / S. Yepifanov, Y. Shoshin, Y. Gusev. – Kharkov : National Aerospace University "Kharkov Aviation Institute", 2013. – 101 p.

2. Yepifanov, S. Afterburners and exhaust systems of turbine engines: Tutorial [Text] / S. Yepifanov, Y. Shoshin, V. Chygryn. Kharkov : National Aerospace University "Kharkov Aviation Institute", 2014. – 32 p.

3. The Jet engine [Text] // The Technical Publications Department of RR plc. – Derby, England. – 1996. – 278 p.

4. Treager, I. E. Aircraft gas turbine engine technology [Text] / I. E. Treager. – 3-rd ed. – Glencoe/McGraw-Hill. 2001. – 677 p.

5. Hunecke, K. Jet engines. Fundamentals of theory, design and operation [Text] / K. Hunecke. – 6-th impression. - Osceola.: Motorbooks IP&W, 2003. – 241 p.

6. Boyce, M.P. Gas turbine engineering handbook [Text] / M. P. Boyce. - 3-rd ed. – Gulf Professional Publishing. – 2006. – 936 p.

7. Проектирование систем силовых установок самолётов [Текст] : консп. лекций / С. В. Епифанов, В. Д. Пехтерев, А. И. Рыженко и др. — Х. : Нац. аэрокосм. ун-т им. Н. Е. Жуковского «Харьк. авиац. ин-т», 2011. – 512 с.

Additional

1. Shoshin, Yu. Basic technical data of Soviet, Ukrainian and Russian cruise engines of aircraft [Text] / Yu. Shoshin, F. Sirenko. – Kharkov : National Aerospace University "Kharkov Aviation Institute", 2015. – 65 p.