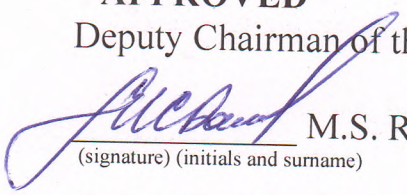
Ministry of Education and Science of Ukraine
National Aerospace University
"Kharkiv Aviation Institute"

Department № 202
"Theoretical mechanics, mechanical engineering and robotic systems"

APPROVED
Deputy Chairman of the EMC 1



M.S. Romanov
(signature) (initials and surname)

September 1, 2021

THE WORK PROGRAM Of COMPULSORY EDUCATIONAL DISCIPLINE

DESIGN OF MACHINE ELEMENTS (TP)
(name of academic discipline)

Branch of knowledge: 13 "Mechanical Engineering", 27 "Transport"
(code and name of the field of knowledge)

Specialties: 134 "Aviation and rocket and space technology", 272 "Aviation transport"
(code and name of the specialty)

Educational programs: "Airplanes and helicopters", "Aircraft engines and power plants", "Design and manufacture of structures made of composite materials", "Aircraft production and repair technologies", "Aircraft engines and power plants", "Maintenance and repair of aircraft and aircraft engines", "Satellites, engines and power plants. Engineering and technical translation", "Rocket and space complexes"

Form of study: full-time

Level of higher education: first (bachelor's)

Kharkiv 2021

Developer:

Koveza Yu. V., Associate Professor 202, Ph.D.
(surname and initials, position, academic degree and academic title) (signature)

The work program was considered at the meeting of the department №202 – "Theoretical mechanics, mechanical engineering and robotic systems"
(name of the department)

Minutes № 11 of June 30, 2021

Head of Department Ph.D., Professor - O.O. Baranov
(scientific degree and academic title) (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 education)</td></tr>
<tr><td>Number of credits - 2</td><td rowspan="11">Areas of knowledge

13 "Mechanical Engineering",
27 "Transport"

Specialties

134 "Aviation and rocket and space technology",
272 "Air transport"

Educational programs

"Airplanes and helicopters", "Aircraft engines and power plants", "Design and manufacture of structures from composite materials", "Technologies for the production and repair of aircraft", "Maintenance and repair of aircraft and aircraft engines", "Aircraft engines and power plants", "Satellites, engines and power plants. Engineering and Technical Translation", "Rocket and Space Complexes "

Level of higher education:

first (bachelor's)</td><td>Compulsory</td></tr>
<tr><td>Number of modules - 1</td><td>Academic year</td></tr>
<tr><td>Number of content modules - 1</td><td>2021/2022</td></tr>
<tr><td></td><td>Semester</td></tr>
<tr><td>The total number of hours is 16/60</td><td>6th</td></tr>
<tr><td rowspan="7">Number of weekly hours for full-time study:
classroom - 1/1
independent work of the student - 2,75</td><td>Lectures</td></tr>
<tr><td>-</td></tr>
<tr><td>Practical, seminar</td></tr>
<tr><td>-</td></tr>
<tr><td>Laboratory</td></tr>
<tr><td>16 hours</td></tr>
<tr><td>Individual work</td></tr>
<tr><td>44 hours</td></tr>
<tr><td>type of control</td></tr>
<tr><td>differential test</td></tr>
</table>

The ratio of the number of hours of classroom classes to independent work is: for full-time study - (16/44) = 0.36.

2. The purpose and objectives of the discipline

Goal is gaining experience and practical skills in solving problems related to the design of parts and components of mechanical engineering.

Task is calculations and design of one of the components of aircraft engines, helicopters, design of drives of technological equipment.

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

- the ability to make informed decisions;
- the ability to calculate the elements of aerospace and rocket technology for strength;
- ability to design and test elements of aviation and rocket and space technology, its equipment, systems and subsystems;
- ability to develop and implement technological processes of production of elements and objects of aviation and rocket and space technology;
- skills of using information and communication technologies and specialized software in training and professional activities.

Program learning outcomes:

- have the skills to determine the loads on the structural elements of aviation and rocket and space technology at all stages of its life cycle;
- to apply in professional activity modern methods of design, construction and production of elements and systems of aviation and rocket and space technology;
- to calculate the stress-strain state, to determine the bearing capacity of structural elements and the reliability of aerospace and rocket systems.

Prerequisites: "Descriptive Geometry", "Engineering and Computer Graphics", "Interchangeability and Standardization", "Mechanics of Materials and Structures", "Theoretical Mechanics", "Theory of Mechanisms and Machines", "Design of machine elements".

Co-requisites: "General Principles of Rational Design", production practice and writing a bachelor's thesis.

3. The program of the discipline

Module 1. Execution of the course project "Design of gearboxes and drives"

Topic 1. Kinematic calculations and preliminary parts strength calculation

Kinematic calculations. Distribution of the total transfer ratio on stages of a reducer and its analysis. Preliminary calculations for the strength of gears (spur, bevel, wave, worm, screw, etc.), which are part of the gearbox. Determination of shaft diameters by a simplified method of their calculation. Preliminary selection of bearing assemblies depending on the nature and level of loads acting on them.

Topic 2. Sketch design of the gearbox

Gradual sketch design: design of transmission parts, shafts, bearings, rational placement of stages in the gearbox housing. Housing design. Choice of type and sizes of seals depending on shaft speed. Selection of torque couplings.

Topic 3. The final design of the gearbox

Revise calculations of the main parts of the gearbox: gears – for static and fatigue strength, shafts – for fatigue strength, bearings – for dynamic load capacity. Check for strength of joint elements (slotted, keyed, threaded, etc.).

Clarification (adjustment) of the gearbox design based on these calculations. Development of a gearbox lubrication system.

Topic 4. Integration of the gearbox into the overall design. Registration of technical documentation

Development of units for mounting the gearbox to the power elements of the aircraft, the transmission of the helicopter or the mechanism of technological equipment (eg, assembly line). Check of elements of couplings on durability. Development of working drawings of 2-3 parts. Registration of a set of technical documentation: assembly drawings of a reducer, working drawings of elements, the specification, the explanatory note - according to requirements of standards.

4. The structure of the discipline

Names of content modules and topics	Number of hours					
	Full-time					
	total	including				
		lec.	pr.	lab.	indv.	indp.
Module 1						
Topic 1. Kinematic calculations and preliminary calculation of parts for strength	12	-	-	2	-	8
Topic 2. Sketch design of the gearbox	14	-	-	5	-	12
Topic 3. The final design of the gearbox	16	-	-	5	-	12
Topic 4. Integration of the gearbox into the overall design. Registration of technical documentation.	18	-	-	4	-	12
Total	**60**			**16**		**44**

5. Topics of seminars

#	Topic Name	Hours

6. Topics of practical classes

#	Topic Name	Hours

7. Topics of laboratory classes

#	Topic Name	Hours
1	Kinematic calculations: preliminary distribution of moments and speeds by drive stages	2
2	Preliminary calculation of parts for strength	2
3	Selection of standard elements and sketch design of the mechanism	2
4	Calculation and selection of rolling bearings	2
5	Calculation of shafts	2
6	Development of a design of the case of a reducer	2
7	Development of working drawings of gearbox parts	2
8	Creation of technical documentation	2
	Total	**16**

8. Independent work

#	Topic Name	Hours
1	Kinematic calculations and preliminary calculation of parts for strength	8
2	Sketch design of the gearbox	12
3	The final design of the gearbox	12
4	Integration of the gearbox into the overall design. Registration of technical documentation.	12
	Total	**44**

9. Teaching methods

Classroom in laboratory classes, individual consultations (if necessary), implementation of a course project under the guidance of a teacher, independent work of students on the materials published by the department (manuals).

10. Methods of control

Carrying out current control. final control in the form of project defense or in the form of a test, differential credit.

11. Evaluation criteria and distribution of points received by students

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

When taking the semester test, the student has the opportunity to receive a maximum of 100 points.

Calculations and explanatory note	Illustrative part	Work defense	Sum
to 20	**up to 40**	**up to 40**	**100**

Semester control in the form of work defense or test is carried out in the presence of a project that is completed in full with the appropriate quality. The test task consists of 30... 60 tasks with the appropriate number of points for each question, so that the sum is 100 points.

11.2 Criteria for evaluating student work during the semester

Satisfactory (60-74). Have a minimum of knowledge and skills. Submit all calculations for the project and graphic support. Must know the classification, purpose, areas of use of parts and general-purpose components used in the project.

Good (75 - 89). Should know the minimum knowledge, submit all tasks. Demonstrate the ability to make and defend calculations and constructive decisions within the period specified by the teacher with a justification of the decisions and measures proposed in the works. Know the classification, purpose, design, areas of use, strength calculations for components of general purpose. Be able to design parts and components of medium complexity.

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

12. Grading scale

The sum of points	Score on a traditional scale	
	Differentiated test	Test
90 - 100	Excellent	Graded
75 - 89	Good	
60 - 74	Satisfactory	
0 - 59	Unsatisfactory	Not graded

13. Methodical support

1. Design of machine elements. Course project [Text] : tutorial / Yu. Koveza, I. Lykhosherst, S. Svitlychniy. – Kh. : National aerospace university «Kharkov aviation institute», 2014. – 180 p.
2. Design of machine elements [Digital resource]: tutorial / V. Dotsenko, Yu. Koveza. – Kharkiv : National Aerospace University «Kharkiv Aviation Institute», 2021. – 224 p.
3. Screw-nut mechanisms [Text] : tutorial / V. G. Dorofeyev, V. N. Dotsenko, Yu. V. Koveza. – Kh. : National aerospace university «Kharkov aviation institute», 2011. – 40 p.

14. Recommended literature

1. Shigley's Mechanical Engineering Design (McGraw-Hill Series in Mechanical Engineering) 10th Edition by Richard Budynas, Keith Nisbett. McGraw-Hill, 2014. – 1104 p.
2. Gupta, J. K. A Textbook of Machine Elements/ R. S. Khurmi, J. K. Gupta. – Eurasia publishing house, 2005. – 1230 p.
3. Spotts, M. F. Design of Machine Elements / Merhyle Franklin Spotts, Terry E. Shoup, Lee Emrey Hornberger. – Pearson Prentice Hall, 2004. – 928 p.
4. Threaded joints : manual / A. Y. Cherniavskyi, K. P. Msallam, Z. A. Pogorelova ; Min. of Education and Science, Youth and Sports of Ukraine, Nat. Aerospace Univ. named after N. Ye. Zhukovskiy «Kharkiv Aviation Inst.». – Kharkiv : National Aerospace University «Kharkiv Aviation Institute», 2011. – 56 p.

15. Information resources

Department websitehttps://education.khai.edu/department/202
https://k202.tilda.ws/
Youtube: 202 XAI
Google Drive:
https://drive.google.com/drive/folders/1DLAKE31GBosgfJx6X8DJJ05C0TIQ0wuG?usp=sharing