MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
National Aerospace University
"Kharkov Aviation Institute"

Aircraft engine design department (№ 203)

APPROVED
Head of project team

_____ *Bezuglyi Sergey*
(signature) (first and last name)

«_____» _____ 2020

SYLLABUS OF AN ACADEMIC DISCIPLINE

COMPUTER AIDED DESIGN
(name of academic discipline)

Field of education *13 «Mechanical Engineering»*
(code and name of a field of education)

Field of study *134 «Aviation and Spacecraft Technologies»*
(code and name of field of study)

Educational program *Operational diagnostics, maintenance and repair of aircraft engines and PP*
(code and name of educational program)

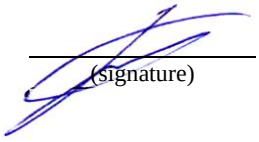
Form of training *Day studies*

Level of higher education *First (bachelor)*

Kharkiv 2020

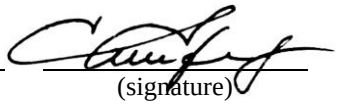
Working program *Computer Aided Design*
(name of academic discipline)
for students of a field of study *134 «Aviation and Spacecraft Technologies»*
educational program *Operational diagnostics, maintenance and repair of aircraft engines and PP*

« *1* » June 20*20* *7* *p.*

Person, who developed the syllabus *Martseniuk Yevgen, assist professor* 
(author, job, academic degree and rank) (signature)

Working program was approved at the meeting of the department
Aircraft Engine Design
(department)

Minutes № 1 dated « 28 » August 2020

Head of department *Dr. Sc., Professor*  *Sergiy Yepifanov*
(academic degree and rank) (signature) (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 – 5,5</td><td>Field of education:
13 «Mechanical Engineering»
(cipher and name)</td><td>Variable</td></tr>
<tr><td>Modules – 2</td><td rowspan="4">Field of study:
134
«Aviation and spacecraft technologies»
(cipher and name)</td><td>Academic year:</td></tr>
<tr><td>Semantic modules – 2</td><td>2020 / 2021</td></tr>
<tr><td>Individual task
Settlement and graphic work
(title)</td><td rowspan="2">Semester</td></tr>
<tr><td>Total number of academic hours – 64*/165</td></tr>
<tr><td rowspan="8">Number of academic hours for full-time tuition:

auditorium – 4

independent work – 6,3</td><td rowspan="8">Educational program:
Operational diagnostics, maintenance and repair of aircraft engines and PP

Higher education:
First (Bachelor)</td><td>4-th</td></tr>
<tr><td>Lectures *</td></tr>
<tr><td>32 a.h.</td></tr>
<tr><td>Practices, seminars *</td></tr>
<tr><td>-</td></tr>
<tr><td>Laboratory activities *</td></tr>
<tr><td>32 a.h.</td></tr>
<tr><td>Independent work</td></tr>
<tr><td>101 a.h.</td></tr>
<tr><td>Form of examination</td></tr>
<tr><td>Credit</td></tr>
</table>

The ratio of hours of classes to independent work is: for full-time education - 64 / 101.

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

2. Goals and purposes of discipline

Goal: modeling components and units of aircraft engines and power plants.

Task: study of methods and approaches of three-dimensional modeling of aircraft engine design in SolidWorks software package.

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

General competencies: *Skills in the use of information and communication technologies. Ability to work both independently and in a team with representatives of other professional groups. Ability to learn and master modern knowledge. Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society, and place in the development of society, engineering and technology; ability to use different types and forms of physical activity to relax and lead a healthy lifestyle. Knowledge and understanding of the subject area and understanding of the features of the specialty. Ability to think abstractly, concretely and generalized, to analyze and synthesize*

Special (professional) competencies: *Ability to develop and implement manufacturing processes for the production of elements and objects of aerospace engineering. Skills in the use of information and communication technologies and specially configured software in studding and professional activities.*

Program learning outcomes: *To have the means of modern information and communication technologies to the extent sufficient for studding and professional activities. To explain their decisions and the basis for their adoption to specialists and non-specialists in a clear and unambiguous form. To have the skills of self-study and autonomous work to refreshing professional skills and solve problems in a new or unfamiliar environment. To have the skills to determine loads on structural elements of aerospace engineering at all stages of its life cycle. To calculate the stress-strain state, determine stability margins of structural elements and the reliability of aerospace engineering.*

Interdisciplinary links: engineering materials science, aviation materials science, machine parts and construction basics, mechanics of materials and structures, technology of structural materials, general arrangement of aviation engines and power plants.

3. Course content

Module 1
Semantic module 1
3D MODELLING

TOPIC 1. Designing with the help of CAD/CAM/CAE systems: computer aided design and CAD/CAM/CAE systems; main part of geometrical modelling in designing, engineering computations, development of manufacturing processes; principles of computer-aided geometrical modelling; parameterized geometrical models; SolidWorks as a basis for engineering computational program suites.

TOPIC 2. Creating and editing sketches in SolidWorks: main principles of sketch plotting; program interface; purpose of reference geometry; simple sketches; complex sketches; three-dimensional sketches.

TOPIC 3. Solid modelling of the parts and assembly elements in SolidWorks: main principles of parts modelling; standard means of elementary geometric primitive creation; model editing; array of solid elements; multicomponent assembly modelling technique.

Modular testing

Module 2
Semantic module 2
FEM FOR ENGINEERING CALCULATIONS

TOPIC 4. Implementation of FEM in engineering practice: concept of finite element; taking into account a nonlinearity in FEM procedures.

TOPIC 5. Carrying out thermal, structural and vibration analysis in SolidWorks Simulation: implementation of finite element calculations in SolidWorks Simulation; basic steps: solid model creating, defining the material properties, creating the finite element mesh, setting the boundary conditions and loads, carrying out calculation, result visualization; example of design thermal analysis; example of design structural analysis.

TOPIC 6. Estimating the part junction stressed condition in SolidWorks Simulation: types and purposes of Hertzian boundary conditions; Hertzian problem solving on the example of estimating the end slot stressed condition.

Modular testing

4. Course arrangement

Names of Modules and Topics	Number of hours				
	full-time tuition				
	total	namely			
		lec	pr	lab	i.w.
1	2	3	4	5	6
Module 1 Semantic module 1 3D Modelling					
Topic 1. Designing with the help of CAD/CAM/CAE systems	4	2	-	-	2
Topic 2. Creating and editing sketches in SolidWorks	14	4	-	4	5
Topic 3. Solid modelling of the parts and assembly elements in SolidWorks	84	14	-	20	42
Modular testing	1	1	-	-	-
Totally for the module No 1	**93**	**20**	**-**	**24**	**49**
Module 2 Semantic module 2 FEM for engineering calculations					
Topic 4. Implementation of FEM in engineering practice	6	2	-	-	4
Topic 5. Carrying out thermal, structural and vibration analysis in SolidWorks Simulation	34	6	-	6	20
Topic 6. Estimating the part junction stressed condition in SolidWorks Simulation	18	4	-	2	8
Modular testing	1	1	-	-	-
Totally for the module No 2	**52**	**12**	**-**	**8**	**32**
Individual research task Settlement and graphic work on the topic of: *"The stress analysis of engine part by finite element method"*	20	-	-	-	20
Totally	**165**	**32**	**-**	**32**	**101**

5. Laboratory activities

№ з/п	Назва теми	Кількість годин
1	Getting knowledge of SolidWorks interface	1
2	Creating and editing sketches in SolidWorks	3
3	Solid modelling of the parts in SolidWorks	16
4	Solid modelling of assembly elements in SolidWorks	4
5	Carrying out structural analysis in SolidWorks Simulation	2

6	Carrying out thermal analysis in SolidWorks Simulation	2
7	Carrying out vibration analysis in SolidWorks Simulation	2
8	Estimating the part junction stressed condition in SolidWorks Simulation	2
	Totally	**32**

6. Independent work

№	Topic	Hours
1	Graphical interface in SolidWorks suite	2
2	Working procedure with the SolidWorks suite	1
3	Main principles of creating and editing three-dimensional models of major aircraft engine elements: blades and disks of a compressor or turbine, pistons, connecting rod	46
4	Solving the main engineering problems (strength, heat conductivity, buckling and vibration analysis of design elements)	32
5	Carrying-out the settlement and graphic work	20
	Totally	**101**

7. Settlement and graphic work

1. The topic of the settlement and graphic work is “The stress analysis of engine part by finite element method”.

Stage of the work:

– studding the drawing of the chosen part of gas turbine engine;
– creating a 3D model of the part;
– studding the operational conditions of the part and choosing the loading scheme, determination of loads acting on the part;
– carrying-out the stress analysis;
– drawing-up the explanatory report;
– defense of the work.

8. Learning methods

Course consist of:

- lectures;
- laboratory activity;
- independent work;
- test.

During lecture course student gets to know main concepts, patterns, theoretical basics necessary in laboratory activity and independent work.

Lectures give an overview of material and set the main tasks.

Laboratory course bases on analytical object (part, assembly) description and it solid modelling in SolidWorks suite. Students work in groups in 2-3 person to improve communication skills and team work.

Main form of learning is independent work. It cannot be done without preliminary knowledge given in lecture. During independent work, students study lecture material, prepare to laboratory works, make settlement and -graphic task.

9. Questions for the test

Topics on 3D modelling
Module 1
Semantic module 1

1. Feature manager design tree, its purpose, operation with tree elements.
2. A sketch, common principles of creating proper sketch.
3. Sketch interconnections, purpose of interconnections, common types of interconnections.
4. Creating bosses and cuts, order of their creation, sketch requirements during their creation.
5. Elements along the path, main principles of creating, sketch requirements during their creation.
6. Loft elements, main principles of creating, sketch requirements during their creation.
7. Part configurations, purpose of configurations, work with configurations.
8. Drawings. Draw creation, part addition.
9. Plotting the section on the drawing (action order).
10. Creating the auxiliary views on the drawing.
11. Assemblies, principles of assembly creation.
12. Creating the reference geometry, purpose and creation order.
13. Curves, types of available curves and order of their creation.

Topics on engineering analysis
Module 2
Semantic module 2

1. SolidWorks Simulation suite, its purpose, possibilities.
2. Static analysis, its purpose, possibilities, estimation order.
3. Thermal analysis, its purpose, possibilities, estimation order.
4. Thermal stress analysis, its purpose, possibilities, estimation order.
5. Natural vibration frequency analysis, its purpose, possibilities, estimation order.
6. Buckling analysis, its purpose, possibilities, estimation order.

10. Testing

For this purpose, the material of the subject is divided into two modules:

1. Three-dimensional modelling.
2. Engineering basics of FEM analysis.

Module 1 is passed during 12-th week (one attempt), module 2 is passed during 16-th week (one attempt).
Before passing modulus, student must make all laboratory works, individual task and independent work of this modulus.

Execution of laboratory works – in *electronic form*, defense – *orally*.

Term of the home task defense – *14-th* week. Delay of defense on one week – 2 points minus; 2 weeks – 4 points minus.

Semester 4 – *credit.*

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

11.1. 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
Module 1 Semantic module 1			
Work at lectures	0…0.5	10	0…5
Execution and defense of laboratory (practical) works	1…2	12	12…24
Modular testing	12…18	1	12…18
Module 2 Semantic module 2			
Work at lectures	0…0.5	6	0…3
Execution and defense of laboratory (practical) works	1…2	4	4…8
Modular testing	12…18	1	12…18
Execution and defense of individual task	20…24	1	20…24
Total for semester			**60…100**

Semester testing (examination) is held in case the student gives up points of modular testing and is permitted to the examination. The permission is given if the student has finished and passed all laboratory and practical works and also successfully defended the home task.

Maximum total score of the examination is 100 points.

The examination card is composed of three theoretical questions and one practical task. The theoretical questions are distributed as follows:

– the first question is on topics from Module 1;
– the second question is on topics from Module 2;
– the third question is on problem solved in IRT.

The practical task concerns creating an assembly consists of two simple parts and its analysis – structural, thermal or modal.

Maximum number of points for each question is 25.

11.2. Qualitive evaluation criteria

To get positive mark, the student must

know:

– the SolidWorks purpose and its availabilities;
– the designing tree, its purpose, operations with its elements;
– the main principles of correct sketching;
– the relations between sketch entities, their purposes;
– the methods of boss/base and cut creating (extruded, revolved, lofted, swept), order of creating, requirements for sketch;
– editing part, purpose of configuration, work with configuration;
– the drawing creation, adding an additional view of part or assembly to drawing, creating section and detailed views and broken-out section;
– the principles of creating an assembly;
– the purpose of reference geometry, its creating;
– creating the curves, types of available curves and technique of their creation;
– the purpose and availabilities of the SoloidWorks Simulation;
– the purpose, availabilities and technique of carrying-out a structural analysis;
– the purpose, availabilities and technique of carrying-out a thermal analysis;
– the purpose, availabilities and technique of carrying-out an analysis of thermal-stress state of part;
– the purpose, availabilities and technique of carrying-out a modal analysis;

– the purpose, availabilities and technique of carrying-out a buckling analysis;

know how:

– to create a 3-D model of part and assembly;
– to carry-out the analysis of stress, thermal state and modal analysis;
– to create drawing of part and assembly.

11.3. Criteria of the student evaluation during semester

Satisfactory (60-74). The student must have the required minimum of knowledge. He must finish and pass all laboratory and practical works, defend the individual task, pass modular testing with positive mark. He must know the main principles of creating sketches and 3-D models. The student must know the procedure of structural and thermal analysis by Finite Element Method. The student must be able to create a 3-D model of simple parts.

Good (75-89). The student must be proficient in minimum knowledge. He must finish and pass all laboratory and practical works, defend the individual task with good mark, pass modular testing with positive mark. The student must know the relations between sketch entities, mates between components of assembly. The student must know how to create complex surfaces. The student must be able to make drawings, define dimensions with tolerances.

Excellent (90-100). He must finish and pass all laboratory and practical works, defend the individual task with good or excellent mark, pass modular testing with excellent mark (one or two modules with "good" mark and minimum 80 points are permitted). Know main and additional material in full scale. The student must be able to create complex assemblies using «upward» and «downward» technique. The student must create models of complex parts consist of no less ten steps (elements) and perform structural, thermal and modal analysis of them. The student must explain how to create the surface model and casting mold.

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 t

12. Recommended literature for the course

Main

1. Reyes A. Beginner's Guide to SoloidWorks 2013: Level I [Text] / Alejandro Reyes. – SDC Publication, 2013. – 480 p.
2. Tran P. SolidWorks 2013 Part I – Basic Tools [Text] / Paul Tran. – SDC Publication, 2013. – 596 p.

Additional

1. Help files SolidWorks.
2. Help files SolidWorks Simulation.