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MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
National Aviation University
Faculty of Air Navigation, Electronics and Telecommunications
Department of Aviation Computer-Integrated Complexes

AGREED

Dean of Faculty of Air Navigation, Electronics and Telecommunications

_____ Sergey ZAVGORODNYI

"___"_____ 2022

APPROVED

Vice-Rector for Academics

_____ Anatolii POLUKHIN

"___"_____ 2022

Quality management system

EXTENDED PROGRAM
on
"Active Control Systems of Aircraft"

Educational Professional Program: "Computer-Integrated Technological Processes and Production"

Field of study: 15 «Automation and Instrumentation»

Specialty: 151 " Automation and Computer-Integrated Technologies"

Training Form	Seme-ster	Total (hours/credits ECTS)	Lec-tures	Pract. classes	Lab. classes	Self-study	HT/ CGP/ CW	TP/CP	Semester Grade
Day Form	1	120/4,0	17	-	17	86	-	CP-1s	Exam-1s

Index CM - 2 - 151 - 2 / 21 - 2.1.4

The Extended Program on «Active Control Systems of Aircraft» is developed on the basis of the Educational Professional Program «Computer-integrated technological processes and production», Curriculum and Extended Curriculum of Education Seekers Training for «Master» CM - 2 - 151 - 2 / 21 and ECM - 2 - 151 - 2 / 21 for the Specialty 151 "Automation and Computer-Integrated Technologies" and corresponding normative documents

Developed by:
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Integrated Complexes Department _____ Mykola FILIASHKIN

Discussed and approved by the Graduate Department for Specialty 151 «Automation and Computer-Integrated Technologies», Educational Professional Program «Computer-integrated technological processes and production» – Aviation Computer-Integrated Complexes Department, Minutes № __ of « » _____2022.

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The Extended Program was discussed and approved by the Scientific-Methodical-Editorial Board of the Faculty of Air Navigation, Electronics and Telecommunications, Minutes №___ as of «___» _____ 2022

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"___"_____ 2022

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CONTENT

INTRODUCTION

The Extended Program on «Active Control Systems of Aircraft» is developed on the basis of "Methodical instructions for the development and design of the Extended Program for the subject", enacted by the order as of 29.04.2021 № 249/od and corresponding normative documents.

1. EXPLANATORY NOTE

1.1. Place, objectives, tasks of the subject.

The place of the subject «Active Control Systems of Aircraft» in the system of professional training**.**

This subject is the theoretical basis of the set of knowledge and skills that form the aviation profile of a specialist in the field of automation and computer-integrated technologies.

The aim of teaching the discipline is to provide future specialists with the basics of building promising automated flight control systems. The acquired knowledge allows solving issues of design, research, control and operation of modern aircraft control systems.

The tasks of the discipline is:

- achieving a level of knowledge sufficient to solve the tasks of developing and analyzing aircraft control systems;
- formation of practical skills in research, certification and operation of active control systems of Aircraft (ACSA).

1.2. Learning outcomes the subject makes it possible to achieve.

The study of the academic discipline involves the formation of program learning outcomes for applicants in accordance with the educational and professional program "Computer-integrated technological processes and production", in particular:

ПР02 - to create highly reliable automation systems with a high level of functional and information security;

ПР13 - to service and repair aviation systems and complexes, computer-integrated production;

ПР15 - to understand various tools and strategies relevant to the diagnosis of computer-integrated production and automated control systems of aviation equipment.

1.3. Competences the subject makes it possible to acquire.

As a result of studying this discipline, the student acquires the following **program competencies**:

- ІК - the ability to solve complex tasks and problems of automation and computer-integrated technologies in professional activities;
- ЗК2 - the ability to generate new ideas (creativity);
- ЗК3 - the ability to abstract thinking, analysis and synthesis;
- СК2 - the ability to design and implement highly reliable systems of active control of aircraft and their application software, for the implementation of control functions;
- СК6 - the ability to apply the methods of modern control theory for the analysis and synthesis of the latest on-board control systems.

1.4. Interdisciplinary connections.

The educational discipline «Active Control Systems of Aircraft» interacts with the discipline «Methodology of Applied Research in the Field of Automation and Computer Integrated Technologies», which is studied in parallel with it and complements each other, and also provides the study of the discipline «Flight and Navigation Complexes of Aircraft»

2. COURSE TRAINING PROGRAM ON THE SUBJECT.

2.1. The subject content

The educational material of the subject «Active Control Systems of Aircraft» is structured on a modular principle and consists of two educational modules, namely:

- educational **module No. 1 "Adjustment of aircraft stability and controllability characteristics"**;
- educational **module No. 2 "Newest modes of operation of Active Control Systems of Aircraft"**, each of which is logically complete, independent and integral part of the curriculum. Its mastering has in view module test and analysis of its completion.

A separate **3rd module** (educational component) is a course project (CP), which is completed in the 1st semester. KP is an important component of consolidation and deepening of theoretical and practical knowledge and skills acquired by the student in the process of assimilation of the educational material of the discipline

2.2. Modular structuring and integrated requirements for each module

Module No. 1 "Adjustment of aircraft stability and controllability characteristics"

Integrated requirements of module No 1:

Know:

- mathematical models of the spatial movement of the aircraft as a control object and its simplified mathematical models;
- the issue of complex correction of aircraft stability and controllability..

Be able:

- to study the stability and controllability contours of the aircraft by means of mathematical modeling.

Topic 1. **«Purpose of Active Control Systems of Aircraft»**

Ways of improving prospective aircraft. Problems solved by active flight control systems of aircraft. Multifunctional systems of automatic flight control of an aircraft as an example of active control systems. Electrical remote control systems. Thrust vector control. Possible structural diagrams of active control systems of the aircraft.

Topic 2. **«Comprehensive correction of the stability and controllability characteristics of the aircraft»**

Criteria for evaluating the aerobatic characteristics of the aircraft. Self-adjusting control regulation machines. Complex automatic machines of longitudinal control. Control of a statically unstable aircraft. Features of the dynamics of lateral movement of the aircraft. Complex automatic machines of lateral control. Parrying cross-connections of aircraft movement. Blocks of cross connections.

Topic 3. **«Automatic aircraft balancing»**

Requirements for the balancing characteristics of the aircraft. Automatic balancing systems (SAB): structural diagram of SAB; adjustment of the balancing curve; implementation of the balancing curve; compensation of longitudinal moments arising when the wing mechanization is released or removed.

Module No. 2 "Newest modes of operation of Active Control Systems of Aircraft"

Integrated requirements of module No 2:

Know:

- features of the construction of control loops of an elastic aircraft;
- contours of direct control of aerodynamic forces.

Be able:

- to study the dynamic characteristics of the circuit of direct control of aerodynamic forces analytically and by means of mathematical modeling.

Topic 1. **«Direct control of aerodynamic forces»**

Traditional instantaneous control of the aircraft and its shortcomings. The principle of direct control of aerodynamic forces, bodies of direct control of aerodynamic forces. Correcting the shortcomings of traditional instantaneous control. Solving control influences and for creating new forms of aircraft movement. Principles of adaptive wing control. Reduction of maneuvering loads and increase of resource. Anti-flutter systems.

Topic 2. «**Peculiarities of the construction of control loops of an elastic aircraft»**

Approaches to obtaining mathematical models of an elastic plane. Mathematical models of an elastic aircraft. Mathematical model of the longitudinal motion of the aircraft taking into account aeroelastic vibrations. The influence of elastic deformations of the structure on the dynamics of automatic control circuits. Aeroautoelastic oscillations of the aircraft structure. Ways to reduce the impact of aeroautoelastic vibrations. Damping and damping of elastic deformations of the structure.

Topic 3. **«Automation of aerobatic restrictions»**

General characteristics of aerobatic limitations of aircraft. Ways of warning the pilot about approaching dangerous flight modes. Ways of automating aerobatic restrictions. Peculiarities of aircraft dynamics at large angles of attack. Implementation of aerobatic restrictions. Automata limiting limit modes.

Module No. 3. «Course Project»

The course project is carried out in the 1st semester, in accordance with the methodical recommendations approved in the established order with the aim of consolidating and deepening the theoretical knowledge and skills acquired by the student in the process of mastering all the educational material of the discipline.

The aim of the course project is to synthesize and analyze the contours of complex correction of the stability and controllability characteristics of the aircraft.

To successfully complete the course project, the student must know the mathematical models of the aircraft as a control object and its simplified mathematical models; typical circuits of automatic control of an aircraft, to be able to investigate the stability and quality of transient processes in the circuits of automatic control of the movement of aircraft analytically and by means of mathematical modeling.

2.3. Training schedule of the subject.

№	Topic	Academic hours			
		Total	Lectures	Lab. classes	Self-study
Module №1 «Adjustment of aircraft stability and controllability characteristics»					
1.1	Purpose of Active Control Systems of Aircraft	**1 semester**			
		4	2	-	2
1.2	Comprehensive correction of the stability and controllability characteristics of the aircraft	16	2 2	2 2	8
1.3	Automatic aircraft balancing	14	2	2 2	8
1.4	Module test 1	3	-	1	2
Total for Module 1		**37**	**8**	**9**	**20**
Module №2 «Newest modes of operation of multifunctional automated flight control systems»					
2.1	Direct control of aerodynamic forces	14	2	2 2	8
2.2	Peculiarities of the construction of control loops of an elastic aircraft	16	2 2	2 2	8
2.3	Automation of aerobatic restrictions	4	2	-	2
2.4	Module test 2	4	1	-	3
Total for Module 2		**38**	**9**	**8**	**21**
Module №3 «Course Project»					
3.1	Synthesis and analysis of the contours of the complex correction of the stability and controllability characteristics of the aircraft	45	-	-	45
Total for Module 3		**45**	**-**	**-**	**45**
Total for 1 semester		**120**	**17**	**17**	**86**
Total for the discipline		**120**	**17**	**17**	**86**

2.4. Questions List for Examination

The list of questions and the content of tasks for preparation for the exam are developed by the leading teacher of the department in accordance with the work program, approved at the meeting of the department and brought to the attention of students.

3. BASIC CONCEPTS OF GUIDANCE ON THE SUBJECT

3.1. Teaching methods

Both subject-oriented and individually-oriented learning technologies are used to activate the educational and cognitive activity of students during the study of the discipline. Laboratory work mainly uses the Case Study method, and lectures and presentations and interactive learning technologies are used.

3.2. List of references

Basic literature

3.2.1 Синєглазов В.М., Філяшкін М.К. Автоматизовані системи управління повітряних суден. К., НАУ. 2002.-465 с..

3.2.2 Синєглазов В.М., Решетняк Є.П., Зіатдінов Ю.К. Активне управління як засіб підвищення ресурсу повітряних суден. К., Техніка, 1998.-230 с.

3.2.3 Синєглазов В.М., Тупіцин М.Ф., Філяшкін М.К., Гурська О.О. Aircraft Active Control Systems //Навчальний посібник. – К.: НАУ, 2010. – 160 с.

Additional literature

3.2.4 Jeffry Block, Heather Gilliatt, Active control of an aero elastic structure, AIAA, Aerospace Sciences Meeting & Exhibit, 35th, Reno, NV, 1997, 6-9..

3.2.5 Філяшкін М.К., Рогожин В.О. Синтез контурів перехресних зв'язків у системах штурвального управління “Матеріали IV Міжнародної науково-технічної конференції АВІА-2001”, т.2: – К.: НАУ, 2002.

3.3 Information resources on the Internet

3.3.1 http://dic.academic.ru/dic.nsf/enc_tech/1559/

3.3.2 http://www.razlib.ru/tehnicheskie_nauki/sverhzvukovye_samolety

3.3.3 http://www.flxsys.com/aerospace.shtml

4. RATING SYSTEM OF KNOWLEDGE AND SKILLS ASSESSMENT

4.1. Assessment of certain types of academic work performed by the student is carried out in points in accordance with table 4.1.

Table 4.1

Type of Academic Work	Maximum Grade Values	Type of Academic Work	Maximum Grade Values
Semester №1			
Module №1 «Adjustment of aircraft stability and controllability characteristics»		**Module № 2** «Newest modes of operation of ACSA »	
Execution and defending laboratory works (total)	7б×4 = 28	Execution and defending laboratory works (total)	7б×4 = 28
For carrying out module test №1, a student must receive not less than	*17*	*For carrying out module test №2, a student must receive not less than*	17
Module Test №1	12	Module Test №2	12
Total for the Module 1	40	**Total for the Module 2**	40
		Total for modules 1, 2	**80**
		Semester exam	**20**
		Total for the subject	**100**

Continuation of the Table 4.1

Module №3 «Course project»

Type of Academic Work	Maximum Grade Values
Semester №1	
Execution of the course project	60
Defending of the course project	40
Execution and defending of the course project	**100**

The credit rating is determined (in points and on a national scale) based on the results of all types of educational work during the semester.

4.2. The kind of academic work, performed by a student, has been passed, if a student got positive grade.

4.3. The grades a student has been given for the different kinds of academic work the summed up and the result constituting a Current Module Grade is entered into the Module Grade Register.

4.4. The total modular grade obtained by the student based on the results of the execution and defense of the course project in values, according to the national scale and the ECTS scale, is entered in the information of the module control, as well as in the study card, the score book and in the Diploma Supplement, for example, as follows: ***94/Ex/A, 85/Good/B, 78/Good/C, 68/Sat/D, 66/Sat./E***, etc.

4.5. The Semester Module Grade and the examination grade are summed up and recalculated according to the National system and ECTS.

4.6. The Total Semester Grade is entered into the credit and examination information, the study card and into the student's record book, for example: ***92/Ex/A, 87/Good/B, 79/Good/C, 68/Sat/D, 65/Sat./E***, etc.

4.7. The Total Subject Grade corresponds to the Total Semester Grade. The Total Subject Grade is entered in the Diploma Supplement.

(Ф 03.02 – 01)

АРКУШ ПОШИРЕННЯ ДОКУМЕНТА

№ прим.	Куди передано (підрозділ)	Дата видачі	П.І.Б. отримувача	Підпис отримувача	Примітки

(Ф 03.02 – 02)

АРКУШ ОЗНАЙОМЛЕННЯ З ДОКУМЕНТОМ

№ пор.	Прізвище ім'я по-батькові	Підпис ознайомленої особи	Дата ознайом-лення	Примітки

(Ф 03.02 – 04)

АРКУШ РЕЄСТРАЦІЇ РЕВІЗІЇ

№ пор.	Прізвище ім'я по-батькові	Дата ревізії	Підпис	Висновок щодо адекватності

(Ф 03.02 – 03)

АРКУШ ОБЛІКУ ЗМІН

№ зміни	№ листа (сторінки)				Підпис особи, яка внесла зміну	Дата внесення зміни	Дата введення зміни
	Зміненого	Заміненого	Нового	Анульо-ваного			

(Ф 03.02 – 32)

УЗГОДЖЕННЯ ЗМІН

	Підпис	Ініціали, прізвище	Посада	Дата
Розробник				
Узгоджено				
Узгоджено				
Узгоджено				
Узгоджено				
Узгоджено				