(Ф 03.02 – 110)

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
«Flight and Navigation Complexes 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	2	180/6,0	18	-	36	126	CGP-2s	-	Exam-2s

Index CM - 2 - 151 - 2 / 21 - 2.1.5

The Extended Program on «Flight and Navigation Complexes 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:
Associate professor of Aviation
Computer-Integrated Complexes Department _____ Oleg SMIRNOV

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.

Guarantor
of the Educational and Professional Program _____ Mykola FILIASHKIN

Head of the Department _____ Victor SINEGLAZOV

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

Head of the SMEB _____ Olexander KRYVONOSENKO

Vice Rector on International
Collaboration and Education

_____ Iryna ZARUBINSKA

"___"_____ 2022

Document level – 3b
The Planned term between revisions – 1 year
Master copy

CONTENT

INTRODUCTION

The Extended Program on «Flight and Navigation Complexes 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 «Flight and Navigation Complexes of Aircraft» (FNC) 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 form students' abilities to:

- design, modify and research information and control complexes;
- use various mathematical methods of optimization when designing flight and navigation complexes of aircraft.

The tasks of the discipline is:

- achieving a level of knowledge sufficient to solve the tasks of development and analysis of algorithmic and software of modern FNC;
- formation of practical skills in research, certification and operation of complex FNC.

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:

ПРН02 - to create highly reliable automation systems, in particular navigation systems, with a high level of functional and information security of software and technical means;

ПРН 08 - apply modern mathematical methods, methods of automatic control theory, reliability theory and system analysis for research and creation of highly reliable pilotage and navigation complexes of aircraft;

ПРН 10 - develop and use specialized software and digital technologies to create automation systems of complex technical objects, professionally own special software tools;

ПРН 13 - maintain and repair aviation systems and complexes.

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;
- ЗК1 - the ability to conduct research at the appropriate level;
- ЗК2 - the ability to generate new ideas (creativity);
- ЗК3 - the ability to abstract thinking, analysis and synthesis;
- СК - the ability to automate complex aviation complexes, create cyber-physical systems of aviation navigation based on intelligent management methods and digital technologies;
- СК2 - the ability to design and implement highly reliable piloting and navigation complexes of aircraft and their application software, for the implementation of management functions and information processing;
- СК3 - the ability to apply modeling and optimization methods to research and improve the efficiency of systems and processes of managing complex technological and organizational-technical objects in aviation;
- СК5 - the ability to integrate knowledge from other fields, apply a systematic approach and take into account non-technical aspects when solving engineering problems and conducting scientific research;
- СК8 - the ability to develop the functional, technical and informational structure of pilotage and navigation complexes using network and information technologies and human-machine interface tools.

1.4. Interdisciplinary connections.

The educational discipline «Flight and Navigation Complexes of Aircraft» is based on the knowledge of such disciplines as "Methods of Modeling and Optimization of Systems and Processes" and "Applied Identification Theory" and interacts with the discipline "Algorithmic and Information Support of Computer-Integrated Systems", which are studied in parallel with it and complement each other.

2. COURSE TRAINING PROGRAM ON THE SUBJECT.

2.1. The subject content

The educational material of the subject «Flight and Navigation Complexes of Aircraft» is structured on a modular principle and consists of two educational modules, namely:

- educational **module No. 1 "Principles of construction and algorithmic support of FNC "**;
- educational **module No. 2 "Algorithms of the operation of FNC at different stages of flight"**, 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.

2.2. Modular structuring and integrated requirements for each module

Module No. 1 "Principles of construction and algorithmic support of FNC"

Integrated requirements of module No 1:

Know:

- typical construction structures of FNC;
- methods of determining navigational parameters of aircraft movement;
- navigational information processing methods.

Be able:

- independently carry out calculations of the reliability of flight control;
- apply navigational information processing methods

Topic 1. **«Principles of construction and general structure of FNC»**

Integration and complex processing of information as a means of improving the efficiency of the use of civil aviation aircraft. Purposes and tasks solved by FNC. General structural diagram of FNC. Information-navigation and piloting systems as part of FNC.

Topic 2. **«Reliability of flight control when flying along a path»**

Vertical echelon. ICAO requirements for the accuracy of maintaining a given flight echelon. Zonal navigation paths according to ICAO standards. Longitudinal echeloning. ICAO requirements for the accuracy of maintaining a given flight corridor. A general approach to calculating the reliability of flight control.

Topic 3. **«Methods for determining the navigational parameters of aircraft movement»**

Coordinate systems used in BISU and N. Classification of methods for determining navigation parameters of movement. Algorithms for determining the main aerobatic and navigational flight parameters.

Topic 4. **«Navigational information processing and correction algorithms»**

Methods of processing navigational information. Algorithms of complexation. Optimal filtering algorithms. Correction of the calculated coordinates of the current location of the aircraft.

Module No 2 "Algorithms of the operation of FNC at different stages of flight"

Integrated requirements of module No 2:

Know:

- content of preparation of FNC before the flight;
- functioning of the FNC at typical stages of the flight.

Be able:

- carry out system checks and adjustments as part of FNC;
- to independently conduct research into the modes of operation of FNC and the automated control of aircraft trajectories by means of mathematical modeling.

Topic 1. **«Preparation of FNC for flight»**

Flight navigation program. Preparation and input of initial navigation information in FNC. Ways of determining the parking course. The use of airfield topographical equipment in the preparation of FNC for flight. Pilot training for flight. Aviation maps.

Topic 2. «**Functioning of FNC at the stage of take-off and altitude gain»**

The task that solves FNC at the stage of take-off and altitude gain. Automation of management processes at the start-up stage. Takeoff controllers. Automation of control during take-off. Control automation during the climb stage.

Topic 3. **«Functioning of FNC at the stage of flight along the route»**

Tasks that are solved by FNC when performing a route flight. Ways of forming a line of a given path. Algorithms for controlling the lateral movement of an aircraft while flying along a route. Algorithms for bringing the aircraft to the line of the given path. Algorithms for controlling the longitudinal movement of an aircraft while flying along a route. Peculiarities of implementation of algorithms in basic FNC.

Topic 4. **«Functioning of FNC at the stages of pre-landing maneuver and landing»**

Automated departure of the aircraft to the programmed landing airport. Trajectories of the aircraft at the stage before the landing maneuver. ICAO categories for precision approach. Automation of approach and landing. Algorithms of operation of FNC at these stages. Peculiarities of the implementation of landing algorithms in the basic FNC.

2.3. Training schedule of the subject.

№	Topic	Academic hours			
		Total	Lectures	Lab. classes	Self-study
Module №1 «Principles of construction and algorithmic support of FNC»					
1.1	Principles of construction and general structure of FNC	**2-nd semester** 20	2	2 2	14
1.2	Reliability of flight control when flying along a path	20	2	2 2	14
1.3	Methods for determining the navigational parameters of aircraft movement	20	2	2 2	14
1.4	Navigational information processing and correction algorithms	22	2 2	2 2	14
1.5	Module test 1	6	-	2	4
	Total for Module 1	**88**	**10**	**18**	**60**
Module №2 «Algorithms of the operation of FNC at different stages of flight»					
2.1	Preparation of FNC for flight	20	2	2 2	14
2.2	Functioning of FNC at the stage of take-off and altitude gain	18	2	2 2	12
2.3	Functioning of FNC at the stage of flight along the route	20	2	2 2	14
2.4	Functioning of FNC at the stages of pre-landing maneuver and landing	18	2	2 2	12
2.5	Performing calculation and graphic papers	10	-	-	10
2.6	Module test 2	6	-	2	4
	Total for Module 2	**92**	**8**	**18**	**66**
	Total for the discipline	**210**	**36**	**36**	**138**

2.4. Calculation and Graphic paper

The purpose of performing CGP is to select the necessary means of correction on the route and the time of its implementation, which ensure the smallest navigation error at the end point of the route. The implementation, registration and protection of the CGP is carried out by the student individually in accordance with methodological recommendations.

2.5. 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 Філяшкін М.К., Рогожин В.О., Скрипець А.В., Лукінова Т.І. Інерціально-супутникові навігаційні системи: навч.посіб. – К.: Вид-во Нац. Авіа. Ун-ту «НАУ-друк», 2009. – 272 с.

3.2.2 В.О.Рогожин, В.М. Синєглазов, М.К. Філяшкін Пілотажно-навігаційні комплекси повітряних суден: Підручник. – К. НАУ, 2005. – 316 с.

3.2.3 M.P. Mukhina, V.O. Rogozhyn, A.V. Skrypets, M.K. Filiashkin Airplane Autonomous Navigation Systems / Manual – K.: NAU, 2019. – 310 p

Additional literature

3.2.4 Захарін Ф.М., Синєглазов В.М., Філяшкін М.К. Алгоритмічне забезпечення інерціально-супутникових систем навігації: Монографія. К., НАУ, 2011.

3.2.5 V.M. Sineglazov, F.M. Zacharin, M.K. Filyashkin Computer-Integrated Navigation Complex of Unmanned Aerial Vehicles / “Methods and Systems of Navigation and Motion Control”: International Conference, October, 13-16, 2010. – K.: «Osvita Ukrainy», 2010. – P. 4 - 8.

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 №2			
Module №1 «Principles of construction and algorithmic support of FNC»		**Module № 2** «Algorithms of the operation of FNC at different stages of flight»	
Execution and defending laboratory works (total)	5б×4 = 20	Execution and defending laboratory works (total)	5б×4 = 20
		Execution and defending CGP	15
For carrying out module test №1, a student must receive not less than	*12*	*For carrying out module test №2, a student must receive not less than*	21
Module Test №1	10	Module Test №2	15
Total for the Module 1	30	**Total for the Module 2**	50
		Total for modules 1, 2	**80**
		Semester exam	**20**
		Total for the subject	**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 Semester Module Grade and the examination grade are summed up and recalculated according to the National system and ECTS.

4.5. 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.

4.6. 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 введен-ня зміни
	Зміненого	Заміненого	Нового	Анульо-ваного			

(Ф 03.02 – 32)

УЗГОДЖЕННЯ ЗМІН

	Підпис	Ініціали, прізвище	Посада	Дата
Розробник				
Узгоджено				
Узгоджено				
Узгоджено				