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

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"___"_____ 2022

APPROVED

Vice-Rector for Academics

_____ Anatolii POLUKHIN

"___"_____ 2022

Quality management system
EXTENDED PROGRAM
on
«Adaptive Control Systems»

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	-	-	Graded test –1 s

Index CM - 2 - 151 - 2 / 21 - 3.3

QMS NAU EP 22.01.09 – 01 – 2022

The Extended Program on «Adaptive Control Systems» 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:
Professor of Aviation
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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

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"___"_____ 2022

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CONTENT

INTRODUCTION

The Extended Program on «Adaptive Control Systems» 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/од and corresponding normative documents.

1. EXPLANATORY NOTE

1.1. Place, objectives, tasks of the subject.

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

The educational subject refers to the disciplines of free choice of students. The discipline is the theoretical basis of the set of knowledge and skills that form the profile of a specialist in the field of automation and computer-integrated technologies.

The aim of teaching the discipline is mastering the theory of adaptive control systems of dynamic systems with further study of methods and means of analysis and synthesis of complex systems. The acquired knowledge allows solving the issues of development, research and operation of modern adaptive control systems.

Tasks of the discipline are:
- achieving a level of knowledge sufficient to solve the tasks of development and analysis of adaptive control systems of modern dynamic systems;
- formation of practical skills in the development and analysis of complex dynamic systems.

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

The study of the academic discipline involves the formation of the following program learning outcomes in the applicants:
- to design, modify and research computer-integrated systems with the principles of adaptive management;
- analyze the structure and work algorithms of adaptive management systems.

1.3. Competences the subject makes it possible to acquire.

As a result of studying this discipline, the student acquires the following **program competencies**:
- 3K2 - the ability to generate new ideas (creativity).
- 3K3 - ability to abstract thinking, analysis and synthesis.;
- CK1 - the ability to automate complex technological objects and complexes, to create cyber-physical systems based on intelligent management methods and digital technologies using artificial intelligence methods;
- CK6 - the ability to apply modern methods of automatic control theory for the development of automated control systems for technological processes and objects..

1.4. Interdisciplinary connections.

The educational discipline «Adaptive Control Systems» interacts with the discipline «Methods of Modeling and Optimization of Systems and Processes», which is studied in parallel with it and complements each other.

2. COURSE TRAINING PROGRAM ON THE SUBJECT.

2.1. The subject content

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

- educational **module No. 1 "The principles of building adaptive control systems"**;

- educational **module No. 2 "Principles of construction of extreme control systems"**, 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 "The principles of building adaptive control systems"

Integrated requirements of module No 1:

Know:

- principles of building adaptive control systems;
- methods of identification in self-adjusting systems.

Be able:

- perform synthesis of adaptive self-adjusting control systems.

Topic 1. **Classification and characteristic features of adaptive management systems.**

The principle of construction and classification of adaptive control systems. Basic concepts and definitions of adaptive management systems. Principles of building self-adjusting control systems. The concept of a secondary quality criterion of self-adjusting systems. Components of self-adjusting systems and their purpose. Self-adjusting systems based on signals of external influences, on dynamic characteristics of the control object, on signals of external influences and on dynamic characteristics of the control object.

Topic 2. **Methods for determining mathematical models of objects and processes in adaptive self-adjusting systems.**

Methods of solving problems of estimating parameters of mathematical models in self-adjusting systems. Scheme of parametric identification of mathematical models in self-adjusting systems, construction principle. Methods of identification in self-adjusting systems.

Topic 3. **Synthesis methods of self-adjusting control systems**

Classification of synthesis methods of self-adjusting control systems. The method of synthesis of self-adjusting control and control systems using an auxiliary operator. The method of synthesis of self-adjusting control and control systems using Lyapunov functions.

Module No. 2 "Principles of construction of extreme control systems"

Integrated requirements of module No 2:

Know:

- methods of finding extremum in extreme control systems;
- types of extreme control systems.

Be able:

- to analyze the algorithms of extreme control systems.

Topic 1. **The purpose and tasks of extreme management, the principle of construction**

The main indicators of the quality of extremum search processes in extreme control systems. Review of methods of finding extremum in extreme control systems. The main types of extreme control systems.

Topic 2. **Extremum search methods in extreme control systems**

The method of finding extremum in extreme control systems The search for extremum in extreme control systems by random methods: blind search method; method of random directions; statistical gradient method.

Topic 3. **Types of extreme control systems**

Extreme control systems with modeling influence, the law of operation, the principle of construction. Extreme control systems with extreme memory, the law of operation, the principle of construction. Extreme control systems of the step type, the law of operation, the principle of construction. Differential systems of extreme control, the law of operation, the principle of construction.

2.3. Training schedule of the subject.

№	Topic	Academic hours			
		Total	Lectures	Lab. classes	Self-study
Module №1 «The principles of building adaptive control systems»					
1.1	Classification and characteristic features of adaptive management systems	**1 semester**			
		14	2	2	10
1.2	Methods for determining mathematical models of objects and processes in adaptive self-adjusting systems	28	2 2	2 2	20
1.3	Synthesis methods of self-adjusting control systems	14	2	2	10
1.4	Module test 1	3	1	-	2
	Total for Module 1	**59**	**9**	**8**	**42**
Module №2 «Principles of construction of extreme control systems»					
2.1	The purpose and tasks of extreme management, the principle of construction	15	2	2	11
2.2	Extremum search methods in extreme control systems	28	2 2	2 2	20
2.3	Types of extreme control systems	15	2	2	11
2.4	Module test 2	3	-	1	2
	Total for Module 2	**61**	**8**	**9**	**44**
	Total for the discipline	**120**	**17**	**17**	**86**

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 Тютюнник А. Г. Оптимальні та адаптивні системи автоматичного керування: навчальний посібник для студ. вузів. - ЖІТІ. – Житомир, 2002.

3.2.2. Бабак В. П., Синєглазов В. М., Таранов С. Г. Самоналагоджувальні інформаційні системи - Київ: НАУ, 2007 - 152с.

3.2.3. Соколов С. В. Оптимальні та адаптивні системи : навчальний посібник / Суми : Сумський державний університет, 2018. –221 с

3.2.4. Marcin Szuster, Zenon Hendzel. Intelligent Optimal Adaptive Control for Mechatronic Systems. - New York: Springer, 2018 - 393 pages/

3.2.5. John H. Miller, Scott E. Page Complex Adaptive Systems: An Introduction to Computational Models of Social Life. - Sebastopol, California, USA: O'Reilly Media, 2018. - 200 pages.

Additional literature

3.2.6 Адаптивні системи автоматичного управління // Міжвідомчий наук.- техн. зб. – Київ : КПІ ім. Ігоря Сікорського, Вид-во «Політехніка». – 2017. – Вип. 1(30). – 248 с..

3.2.7 Мовчан А.П. Навчальний посібник: Адаптивні та параметрично-оптимальні системи управління. Навч. посіб. – К.: НТУУ «КПІ», 2011. – 108 с.

3.3 Information resources on the Internet

3.3.1 http://www.mirknig.com/knigi/1181209388-optimalnye-i-adaptivnye-sistemy.html.

3.3.2 http://www.mirknig.com/knigi/1181209388-optimalnye-i-adaptivnye-sistemy.html

3.3.3. http://www.pereplet.ru/obrazovanie/stsoros/227.html

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 «The principles of building adaptive control systems»		Module № 2 «Principles of construction of extreme control systems»	
Execution and defending laboratory works (total)	5б×4 = 20	Execution and defending laboratory works (total)	5б×4 = 20
Execution of tasks of express control under time of laboratory classes	4б×4 = 16	Execution of tasks of express control under time of laboratory classes	4б×4 = 16
For carrying out module test №1, a student must receive not less than	22	*For carrying out module test №2, a student must receive not less than*	22
Module Test №1	14	Module Test №2	14
Total for the Module 1	50	**Total for the Module 2**	50
		Total for modules 1, 2	**100**
		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. In the case of **Graded test**, the sum of the final semester module grade in points constitutes the final semester rating grade, which is converted into a grade based on the national scale and the ECTS scale.

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 введення зміни
	Зміненого	Заміненого	Нового	Анульо-ваного			

(Ф 03.02 – 32)

УЗГОДЖЕННЯ ЗМІН

	Підпис	Ініціали, прізвище	Посада	Дата
Розробник				
Узгоджено				
Узгоджено				
Узгоджено				