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MINISTRY of EDUCATION and SCIENCE of UKRAINE
National Aviation University
Aerospace Faculty
Airport Technologies Department

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«10» 05 2023

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«10» 05 2023

Quality Management System

COURSE TRAINING PROGRAM
on
«Mathematical Modeling of Airport Technological Processes»

Educational Professional Program: Airport Technologies and Technical Equipment
Field of study: 27 Transport
Specialty: 272 Aviation Transport

Form of training	Semester	Total (hours / ECTS credits)	Lectures	Practicals	Laboratory classes	Self-study	HW/ CGW/ CW	TP/ CP	Form of semester control
Full-time	1	105/3,5	18	–	18	69	–	–	Graded Test 2s

Index: ECM-1-272-2/22-2.1.6

The Course Training Program on «Mathematical Modeling of Airport Technological Processes» was developed on the basis of Educational and Professional Program «Airport technologies and technical equipment», Curriculums № СМ-1-272-2/22, ЕСМ-1-272-2/22 for the «Master» educational degree seekers training for the Specialty 272 «Aviation Transport» and corresponding normative documents.

Developed by:
Professor of
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Discussed and approved by the Graduate Department for the Educational Professional Program «Airport technologies and technical equipment», the Specialty 272 «Aviation Transport» – Department of Airport Technologies, Minutes № 3 of "27" 04 2023.

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«10» 05 2023

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CONTENT

INTRODUCTION

Course Training Program (CTP) of discipline «Mathematical Modeling of Airport Technological Processes» is developed in accordance with the «Methodical recommendations for the development and design of the Course Training Program of the discipline of full-time and part-time forms of education», approved by the rector's order dated 29/04/2021 No. 249/od, and correspondent normative documents.

1. EXPLANATORY NOTES

1.1. Place, objectives, tasks of the subject

This educational discipline is the theoretical basis of totality of knowledge and outcomes, that forms the profile of specialist in the field of the airport technologies and technical equipment.

Purpose of the discipline is to systemize ideas about the peculiarities of technological processes at a modern airport and providing of the ability to use modern simulation modeling technologies for the purpose of their research and automation.

Tasks of learning of the discipline are:

– learning of simulation modeling of technological processes at the airport;

– learning of decision-making techniques for managing of technological processes based on the results of their simulation modeling.

1.2. Learning outcomes the subject makes it possible to achieve

At the end of the course, the student will be able to:

PTO01. Specialized conceptual knowledge, which includes modern scientific achievements in the field of air transport, in particular of airport operation and operation of aviation ground equipment and airport equipment and is the basis for original thinking and research conducting.

PTO02. To apply modern methods of scientific research, organisation and planning of the experiments, digital technologies, methods of data analysis to solve complex problems in the field of air transport, in particular of airport operation and operation of aviation ground equipment and airport equipment.

PTO03. To solve complex problems of creation, operation, maintenance, repair and utilization of objects of air transport, in particular of aviation ground equipment and airport equipment, including at the border with related fields, engineering sciences, physics, ecology and economy.

PTO06. To apply universal and specialized lifecycle management (PLM), computer-aideddesign (CAD), manufacturing (CAM) and engineering research (CAE) systems in professional activities.

PTO07. To develop and to implement energy saving technologies in the field of air transport, in particular of airport operation and operation of aviation ground equipment and airport equipment.

PTO09. To develop and to analyse physical, mathematical and computer models related to the creation, operation, maintenance and repair of air transport, in particular of aviation ground handling facilities and airport equipment.

PTO12. To perform technical and economic calculations, comparison and justification of projects of production, repair, renovation, operation, maintenance of air transport, in particular of aircraft ground equipment and airport equipment.

PTO13. To make effective decisionson functioning of air transport, in particular of airport and the operation of aviation ground equipment and airport equipment, including in difficult and unpredictable conditions; to forecast their development; to identify factors that affect the achievement of goals; to analyze and to com-pare alternatives; to assess risks and possible consequences of decisions.

PTO14. To ensure the quality of production and operation in the field of air transport, in

particular of airport functioning and operation of aviation ground equipment and airport equipment.

PTO15. To search necessary data in scientific literature, databases and other sources, to analyze, to evaluate and to use these data.

PTO16. To determine the properties and characteristics, to calculate the parameters of air transport, in particular of aircraft ground equipment and airport equipment.

PTO17. To develop and to optimize the parameters of air transport, in particular of aviation ground equipment and airport equipment and technological processes at the airport, including using of automated computer modeling and design.

1.3. Competences the subject makes it possible to acquire

As a result of discipline studying, the student must acquire the following **competencies**:

GC01. Knowledge and understanding of the subject area and understanding of professional activity.

GC03. Skills of using of information and communication technologies.

GC04. Ability to conduct research at an appropriate level.

GC05. Ability to search, to process and to analyze information from various sources.

GC06. Ability to identify, to formulate and to solve problems.

GC07. Ability to make informed decisions.

GC09. Ability to evaluate and to ensure the quality of the performed works.

PC01. Ability to develop and to implement scientific and applied projects in the field of air transport, in particular of airport operation and operation of aviation equipment and airport equipment.

PC02. Ability to apply a systematic approach to solving engineering interdisciplinary problems in the field of air transport, in particular of airport operation and operation of aviation ground equipment and airport equipment.

PC03. Ability to take into account legal, social, environmental, ethical, economic and commercial aspects that affect the adoption and implementation of decisions in the field of air transport, in particular of airport operation and operation of aviation ground equipment and airport equipment.

PC04. Ability to integrate knowledge and to solve complex scientific and industrial problems in the field of air transport, in particular of airport operation and operation of aviation ground equipment and airport equipment, taking into account the wider interdisciplinary engineering context.

PC05. Ability to manage technological processes in the field of air transport, in particular of airport operation and operation of aviation ground equipment and airport equipment, which are complex, unpredictable and require new strategic approaches.

PC06. Ability to implement modern technologies, to research, to analyze and to improve technological processes in the field of air transport, in particular of airport operation and operation of aviation ground equipment and airport equipment.

1.4. Interdisciplinary connections

This discipline is based on the knowledge obtained during the preparation for the educational degree «Bachelor» and is the basis for the study of further disciplines, namely: «Philosophical Problems of Scientific Cognition», «Methodology of Applied Research in the Field of Aviation Transport», «Mathematical Methods for Modeling Systems and Processes», «Statistical Estimation and Problem Solving», «Technological Design of Airport Divisions» and the basis of passing of Research Activities in the Field of Airport Technologies and Pre-diploma practice.

2. COURSE TRAINING PROGRAM ON THE SUBJECT

2.1. The subject content

The educational material of the of the discipline is structured as module principle and consists of one educational **module №1 «Mathematical Modeling of Airport Technological Processes»**, which is a logically complete, independent, integral part of the educational discipline, the mastery of it provides a modular control work and analyzing the results of its implementation.

2.2. Modular structuring and integrated requirements for each module

Module №1 «Mathematical Modeling of Airport Technological Processes»

Module №1 integrated requirements:

To know:

– technologies of simulation modeling of technological processes at the airport;

– decision-making methods for managing of technological processes based on the results of their simulation modeling.

To be able:

– to analyze operational properties of technological processes at the airport;

– to simulate technological processes at the airport using the theory of mass service;

– to develop simulation models of technological processes at the airport;

– to conduct a study of the effectiveness of technological processes at the airport using simulation modeling;

– to develop scientifically based recommendations for modernization and creation of new technological processes at the airport.

Module 1. «Mathematical Modeling of Airport Technological Processes»

Topic 1.1. Basics of modeling in the Anylogic environment.

Basics of modeling. Stages of modeling. Classical and system approaches in modeling. Types of models. Basics of simulation modeling. System dynamics. Anylogic simulation environment. User interface of the environment.

Topic 1.2. Basic elements of Anylogic models.

Discrete-event modeling in Anylogic. Process modeling library. Source object. Sink object. Resourcepool block. Object Schedule. Service block. Queue block. Timemeasurestart block. Timemeasureend block. Assembler block. Block Conveyor. Batch block. Space marking. Flow modeling library. Fluidsource block. Fluid Dispose block. Block Tank. Processtank block. Mixtank block. Pipeline block. Block Bulkconveyor. Fluidtoagent block. Agenttofluid block. Library of system dynamics. Accumulator block. Flow block. Block Dynamic variable. Parameter block. Agent modeling. Creating of new agent. Events at Anylogic. Status diagram. Actions diagram. Statistics in Anylogic.

Topic 1.3. Mathematical models of discrete systems.

Basic concepts of mathematical modeling of discrete systems. Applications flow. Strategies of managing of application flows. Classification of mass service models. Parameters and characteristics of mass service systems (MSS). Parameters and characteristics of mass service networks (MSN).

Topic 1.4. Analytical modeling of MSS.

Single-channel MSS with uniform flow of applications. Multi-channel MSS with uniform flow of applications. Single-channel MSS with a heterogeneous flow of applications. Open exponential MSN with uniform flow of applications. Closed exponential MSN with uniform flow of applications. Calculations of characteristics of closed MSN.

Topic 1.5. Numerical modeling of random processes.

The concept of a random process. Parameters and characteristics of a Markov random process. Markov`s models calculation methods. Markov`s models of mass service systems. Markov`s

models of mass service networks.

2.3. Training schedule of the subject

№ ser.	Name of topic	Classes Workload (hours)			
		Full-time education			
		Total	Lectures	Laboratory classes	Self-study
1	2	3	4	5	6
1.1	Basics of modeling in the Anylogic environment	6	2	–	4
1.2	Introduction to the interface and basic principles of modeling in AnyLogic	6	–	2	4
1.3	Discrete-event modeling in Anylogic	6	2	–	4
1.4	Modeling in AnyLogic passenger traffic regulation systems and special transport systems	6	–	2	4
1.5	Flows modeling in Anylogic	6	2	–	4
1.6	Modeling in AnyLogic of car suspension systems	6	–	2	4
1.7	Mathematical models of discrete systems	6	2	–	4
1.8	Modeling in AnyLogic of the fuel level control system in the tank	6	–	2	4
1.9	Analytical modeling of mass service systems	6	2	–	4
1.10	Modeling in AnyLogic technological processes of passengers and baggage check-in at the airport	6	–	2	4
1.11	Analytical modeling of mass service networks	6	2	–	4
1.12	Modeling in AnyLogic gas station operation	6	–	2	4
1.13	Parameters and characteristics of a Markov random process	6	2	–	4
1.14	Modeling in AnyLogic technological processes of aircraft maintenance on the apron	6	–	2	4
1.15	Markov models of mass service systems	6	2	–	4
1.16	Modeling in AnyLogic the operation of a special equipment maintenance station at the airport	7	–	2	4
1.17	Markov models of mass service networks	1	4	6	4
1.18	Module Test № 1	2	–	1	1
Total on the Module № 1		**120**	**18**	**18**	**69**
Total on the 2st semester		**105**	**18**	**18**	**69**
Total on the discipline		**105**	**18**	**18**	**69**

2.4. List of questions for the exam

The list of questions and the content of tasks for the exam preparation are developed by the leading lecturer of the department in accordance with the Course Training Program, approved by the department and informed to the attention of the students.

3. BASIC CONCEPTS OF GUIDANCE ON THE SUBJECT

3.1. Teaching methods

The following educational methods are used during studying the discipline:
– explanatory-illustrative method;
– method of problem exposition;
– reproductive method;
– research method.

These methods realization is provided during lectures, demonstrations, individual tasks solution, reading of educational literature, analysis and resolution of conflict situations during the planning of technological processes at the airport.

3.2. List of references

Main references

3.2.1. Ramin S. Esfandiari, Bei Lu. Modeling and Analysis of Dynamic Systems. 2018 by Taylor & Francis Group, LLC. 619 p.

3.2.2. Borshchev A. The Big Book of Simulation Modeling. 2013. AnyLogic North America. 614 p.

3.2.3. Kai Velten. Mathematical Modeling and Simulation Introduction for Scientists and Engi-neers. 2009 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim. 364 p.

Additional references

3.2.4. Жерновий Ю. В. Імітаційне моделювання систем масового обслуговування: Практикум. – Львів: Видавничий центр ЛНУ імені Івана Франка, 2007. – 307 с

3.2.5. Java: A Beginners Guide, Seventh Edition, 2018, McGraw-Hill Education, 810 p.

3.2.6. The Art of Process-Centric Modeling with AnyLogic. Arash Mahdavi, Simulation Model-ing Consultant, The AnyLogic Company. 314 p.

3.3. Information sources on the Internet

3.3.1. http://www.anylogic.com
3.3.2. http://vensim.com

4. RATING SYSTEM OF KNOWLEDGE AND SKILLS ASSESSMENT

4.1. The current grading of knowledge and skills acquired by the student is carried out according to 5-point system, *rating grade* is given: 1, 2, 3, 4, 5.

4.2. The *current module rating grade* is determined as the average value of the sum of the *rating grades* of all types of classes and control, provided by the educational work program (lectures, laboratory works and practical works, homeworks, TP, CP, testing, module test, graded test and exam, etc.).

4.3. The correspondence of the *current module rating grade* to the minimum value of the student's knowledge mark according to the 100-point scale of the European Credit Transfer System (ECTS) is established according to Table 1 (column 2).

Table 4.1

Current Module Grade	Minimal Grade Value of ECTS	Incentive Points	Total Grade of ECTS	Grade	Index
5	90	0-10	90 - 100	Excellent	A
4,5 - 4,9	82	0-10	82 - 89	Good	B
4,0 - 4,4	75	0-10	75 - 81	Good	C
3,5 - 3,9	67	0-10	67 - 74	Satisfactory	D
3,0 - 3,4	60	0-10	60 - 66	Satisfactory	E
2,5 - 2,9	35	0	35 - 59	Unsatisfactory	FX
1,0 - 2,4	1	0	1- 34	Unsatisfactory	F

4.4 The sum of incentive points according to table 2, which characterize the student's attitude to studying of the discipline (no more than 10 points), is added to the minimum value of the ECTS grade.

Table 4.2

№ ser.	Incentive Criterion	Points
1	Absence of missed classes	0 - 3
2	Activity during classes	0 - 3
3	Defending of works in time	0 - 2
4	Correct behavior	0 - 2

4.5. The sum of the minimal ECTS grade and incentive points are the *Total (Module, Semester) Grade*, which is entered in the module test report, study card, individual curriculum of the student, record book and diploma supplement, for example, as follows: **92 / Excellent / A, 87 / Good / B, 79 / Good / C, 68 / Sat./D, 65 / Sat./E,** etc.

(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	Анульованого			

(Ф 03.02 – 32)

УЗГОДЖЕННЯ ЗМІН

	Підпис	Ініціали, прізвище	Посада	Дата
Розробник				
Узгоджено				
Узгоджено				
Узгоджено				