(Ф 03.02 – 110)

MINISTRY OF EDUCATION AND SCIENCE N OF UKRAINE
National Aviation University
Faculty of Transport, Management and Logistics
Air Transportation Management Department

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«13» 09 2021

APPROVED
Vice-Rector for Academics
_____ Anatolii POLUKHIN
«18» 10 2021

Quality Management System

COURSE TRAINING PROGRAM
on
«Stochastic Processes in Transport Systems»

Educational and Professional Programs: «Air Transportation Management»

Field of Study: 27 «Transport»
Speciality: 275 «Air Transport Technologies»
Specialization: 275.04 «Air Transport Technologies»

Training Form	Semester	Total (hours/ECTS credits)	Lectures	Laboratory Classes	Self-study	HW/ CGP	Semester Grade	Training Form	Semester
Денна	3	120/4,0	17	–	34	69	–	–	Graded Test 3s

Index: СВ-7-275-1/21-3.2

Course Training Program on «Stochastic Processes in Transport Systems» is developed on the basis of Educational and Professional Programs «Air Transportation Management», Bachelor Curriculum and Bachelor Extended Curriculum №СВ-7-275-1/21, №ЕСВ-7-275-1/21 for Speciality 275 «Air Transport Technologies», Specialization 275.04 «Air Transport Technologies» and corresponding normative documents.

Developed by
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Discussed and approved by the Graduate Department for Speciality 275 «Air Transport Technologies», Specialization 275.04 «Air Transport Technologies» and Educational and Professional Program «Air Transportation Management» - Air Transportation Management Department, Minutes № 15 «31» 08 2021

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INTRODUCTION

The Course Training Program of the subject «Stochastic Processes in Transport Systems» " is developed based on the "Methodical guidance for the subject course training program", approved by the order № 249/од, of 29.04.2021 and corresponding normative documents.

1. EXPLANATORY NOTE

1.1. Place, objectives, tasks of the subject.

This training course is the theoretical basis and practical body of knowledge and skills that form the air transport profile of a specialist in the field of knowledge and systematization of knowledge about the functioning of transport systems.

The aim of the subject "Stochastic Processes in Transport Systems" is for students' mastering the discipline makes it possible to clearly understand the structure of processes in transport systems in terms of the theory of operations research and to find solutions of problems that arise during functioning and which are related to the peculiarities of transportation systems construction and their effective development.

The **objectives of the subject are**:

- mastering the basic concepts of the theory of random processes and the theory of queuing;
- mastering the methods of research of queuing systems, their practical use;
- mastering the basic principles and techniques of mathematical modeling of operations, the principles of selection of mathematical and software for the practical implementation of tasks;
- formation of skills of construction of models and the decision of concrete problems on professional activity.

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

- Take responsibility, show public consciousness, social activity and participation in the life of civil society, think analytically, critically understand the world;
- Apply, use modern information and communication technologies to solve practical problems in the organization of transportation and design of transport technologies;
- Investigate transport processes, experiment, analyze and evaluate the parameters of transport systems and technologies;
- Develop, design, manage projects in the field of transport systems and technologies;
- Classify and identify transport processes and systems. Evaluate the parameters of transport systems. Perform system analysis and forecasting of transport systems;
- Evaluate the parameters of traffic flows. Design schemes and networks of transport systems. Develop technologies for operational management of traffic flows;
- Investigate the types and types of transport systems. Find solutions for optimizing the parameters of transport systems. Assess the efficiency of infrastructure and technology of transport systems;
- Organize international transportation. Apply methods of customs documentation. Use of customs control methods;
- Develop conceptual, logical and physical models of the database. Be able to program databases using the SQL language

1.3. Competences the subject makes it possible to acquire.

- Knowledge and understanding of the subject area and understanding of professional activity;
- Ability to abstract thinking, analysis and synthesis;
- Ability to analyze and predict the parameters and performance indicators of transport systems and technologies, taking into account the impact of the external environment;
- Ability to design transport (transport-production, transport-warehousing) systems and their individual elements;
- Ability to assess the operational, technical and economic, technological, legal, social, and environmental components of the organization of transportation;
- Ability to evaluate plans and proposals for the organization and technology of transportation, drawn up by other entities, and make the necessary changes based on the technical and operational parameters and principles of operation of facilities and devices of transport infrastructure, vehicles (vessels);

- Ability to develop and use mathematical and computer models of transport systems and processes for scientific and practical research;

- Ability to use professional knowledge and practical skills of technology, organization and management of air passenger transport to solve engineering problems in production;

- Ability to critically analyze and solve practical problems in the field of air transport and related industries to ensure timely decisions, taking into account technical, regulatory, commercial, political, social and environmental constraints.

1.4. Interdisciplinary connections.

The subject is based on knowledge of such subjects as «Higher Mathematics», «Computer Engineering» and is the basis for the studying such subjects as: «Operations research on transport транспорті».

2. COURSE TRAINING PROGRAM ON THE SUBJECT

2.1. The subject content.

Training material is structured according to module principle and consists of **one educational module, Module № 1 «Markov processes in applied problems of transport management»,** that is logically complete, relatively independent, holistic part of the subject, learning of which provides module test and analysis of its performance.

2.2. Modular structuring and integrated requirements for each module.

Module №1 «Markov processes in applied problems of transport management»

Integrated requirements of module №1:

Know:

- definition and classification of random processes;
- the most important classes of random processes.
- elements of the theory of Markov chains;
- general provisions of the theory of queuing;
- main components of queuing models (QMS);
- classification of QMS;
- some systems of queuing theory and their efficiency indicators;
- types of simulation modeling;
- Monte Carlo method.

Be able to:

- build a graph of system states;
- compose and solve the system of Kolmogorov differential equations;
- determine the stationary distribution of probabilities of system states;
- determine the type of QMS;
- calculate the performance indicators of QMS with failures and expectations.

Topic 1. Random variables and random processes.

The subject of the theory of random (stochastic) processes. Definition and classification of random processes. The most important classes of random processes. Markov processes and their classification. Examples.

Topic 2. Discrete Markov process with discrete time.

The concept of system, state graph, system ergodicity, set of states without output and without input. Cross section of a random process. Implementation of a random process over a period of time. Step function. Definition of the Markov chain. Probabilities of states. Transient probabilities. Vector of initial probability distribution. Homogeneous and inhomogeneous Markov chain. Final (stationary) probabilities of a homogeneous Markov chain.

Topic 3. Discrete Markov process with continuous time.

The density of probabilities of system transitions from state to state. Transition probability density matrix. Kolmogorov system of differential equations. Rules for compiling a system of Kolmogorov differential equations according to the marked graph and the matrix of transition densities. Stationary probability distribution.

Topic 4. Poisson's stationary (simplest) flow of events.

Defining the flow of events. Homogeneous, inhomogeneous, regular, without aftereffects, ordinary, stationary flows of events. Poisson flow of events. The simplest flow of events and its properties. Flow intensity. Correspondence between the exponential distribution and the Poisson distribution. Relationship of Poisson flow of events with discrete Markov processes with continuous time.

Topic 5. The process of death and reproduction.

Definition of the process. Graph of process states. Matrix of densities of probabilities of transitions of process. Limit probability distribution of system states.

Topic 6. Elements of queuing theory.

History and development of queuing theory. Queuing systems (QMS) and their classification. The main components of queuing models Basic concepts: "flow", "queue", "service channel". WMO performance indicators.

Topic 7. Markovsky SMO. Random processes in applied problems of transport management.

Specialized QMS with Poisson distribution. Marked graph of states. Determining the main characteristics of service. QMS with refusals and queues in civil aviation. Calculation of indicators of efficiency of work of SMO.

Topic 8. The concept of the method of statistical modeling of QMS.

Types of simulation. Monte Carlo method. Generating random numbers. Manual imitation of the queue model with one service.

2.3. Training schedule of the subject.

№	Theme	Total, hours			
		Total	Lectures	Labs	Self -study
1	2	3	4	5	6
Module №1 «Markov processes in applied problems of transport management»					
1.1	Random variables and random processes	**3 semester** **14**	2	2 2	8
1.2	Discrete Markov process with discrete time	**14**	2	2 2	8
1.3	Discrete Markov process with continuous time	**14**	2	2 2	8
1.4	Poisson's stationary (simplest) flow of events	**14**	2	2 2	8
1.5	The process of death and reproduction	**13**	2	2 2	7
1.6	Elements of queuing theory	**13**	2	2 2	7
1.7	Markovsky SMO. Random processes in applied problems of transport management	**13**	2	2 2	7
1.8	The concept of the method of statistical modeling of QMS	**15**	2 1	2 2	8
1.9	Module test №1	**10**	-	2	8
Total by the module №1		**120**	**17**	**34**	**69**
Total by the Subject		**120**	**17**	**34**	**69**

3. BASIC CONCEPTS OF GUIDANCE ON THE SUBJECT

3.1. Teaching methods.

In the teaching of the discipline "Operations research on transport ", it is proposed the use of such forms and methods of learning as

- lecture-visualization,
- elements of problem lecture,
- elements of dialogue with the audience (lectures - conversations),

- elements of "brain attack",
- workshops-discussions within the framework of practical occupations,
- business games, presentations.

The implementation of these methods are carried out during lectures, demonstrations, self-study, work with the educational material, analysis and solving problems in the study of operations research.

3.2. List of references (basic and additional).

Basic literature

3.2.1. Крюков М.М., Кравець Т.В., Крижановська Т.В., Коновалюк В.С., Семененко Т.М. Дослідження операцій у транспортних системах у прикладах і задачах. Навч. посіб. для студ. вищ. навч. закл. – К.: ДЕТУТ, 2014. – 199 с.

Additional recommended sources

3.2.2. Козаченко Д.М., Вернигора Р. В., Малашкін В. В. Основи дослідження операцій у транспортних системах: приклади та задачі. – Дніпропетр. нац. ун-т залізн. трансп. ім. акад. В. Лазаряна – Дніпропетровськ, 2015. – 280 с.

3.3. Internet Information resources

3.3.1. http://e-books.ksavm.senet.ru/Books/physics/akulich-i.m.-matematicheskoe-programmirovanie-v-primerah-i-zadachah.pdf

3.3.2. https://tvims.files.wordpress.com/2012/01/d182d0b0d185d0b0-d185-d0b0-d0b2d0b2d0b5d0b4d0b5d0bdd0b8d0b5-d0b2-d0b8d181d181d0bbd0b5d0b4d0bed0b2d0b0d0bdd0b8d0b5-d0bed0bfd0b5d180.pdf

3.3.3. http://eadnurt.diit.edu.ua/bitstream/123456789/8967/1/Kozachenko_textbook.pdf

3.3.4. https://www.scribd.com/doc/316680593/Operations-Research-Hamdy-Taha-pdf

4. RATING SYSTEM OF KNOWLEDGE AND SKILLS ASSESSMENT

4.1. Assessment of certain kinds of student academic work is carried out in accordance with table 4.1.

Table 4.1

Kind of Academic Work	Max Grade Values
3 semester	
Module №1 «Markov processes in applied problems of transport management»	
Carrying out labs (10б x 8)	80 (total)
For admission to complete module test №1, a student must receive not less than	*48 points*
Module test №1	20
Total by the module №1	**100**
Total by the Subject	**100**

4.2. Completed types of educational work are credited to the student, if he received a positive rating for them.

4.3. The sum of rating assessments received by the student for certain types of completed academic work is the current modular rating assessment, which is recorded in the module control.

4.4. The final modular rating obtained by the student based on the results of the course defense and defense in points, on the national scale and ECTS scale is entered in the module control, as well as in the study card, individual student curriculum and Diploma Supplement, for example, as follows: ***92 / Excellent / A, 87 / Good / B, 79 / Good / C, 68 / Sat./D, 65 / Sat./E, etc.***

4.5. The final semester rating is converted into a grade on the national scale and the ECTS scale.

4.6. The final semester rating in points, on the national scale and the ECTS scale is entered in the test report, study card and individual curriculum of the student (record book), for example, as follows: ***92 / Excellent / A, 87 / Good / B, 79 / Good / C, 68 / Sat./D, 65 / Sat./E, etc.***

4.7. The Total Grade for the subject is equal to the average grade from Total Semester Grades with its further transformation into national scale and ECTS system.

(Ф 03.02 – 01)

АРКУШ ПОШИРЕННЯ ДОКУМЕНТА

№ прим.	Куди передано (підрозділ)	Дата видачі	П.І.Б. отримувача	Підпис отримувача	Примітки
	УТиТБ	03.11.21	Шишкіна Н.І.		

(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				