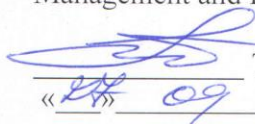# MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
## NATIONAL AVIATION UNIVERSITY
Faculty of Transport, Management and Logistics
Air Transportation Management Department

AGREED
Dean of the Faculty of the Transport,
Management and Logistics

_____ Tetiana MOSTENSKA
« 24 » 09 2021

APPROVED
Vice-Rector for Academics

_____ Anatolii POLUKHIN
« 07 » 10 2021

Quality Management System
## COURSE TRAINING PROGRAM
on
### «Intelligent Technologies on Transport»

Educational and Professional Program: «Air Transportation Management»

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

| Training Form | Semester | Total (hours/credits ECTS) | Lectures | Practicals | Lab. classes | Self-Study | HW/CGP | TP/CP | Semester Grade |
|---|---|---|---|---|---|---|---|---|---|
| Full-time: | 2 | 120/4,0 | 18 | - | 18 | 84 | - | - | Graded test 2s |

Index CM-7-275/21-3.4

Course Training Program on «Intelligent Technologies on Transport» is developed on the basis of the Educational and Professional Program "Air Transportation Management", Master Curriculum and Extended Master Curriculum №CM-7-275/21, №ECM-7-275/21 for Speciality 275 «Air Transport Technologies», Specialization 275.04 «Air Transport Technologies» and corresponding normative documents.

Developed by:
Head of the Department of the
Air Transportation Management Department _____ Dmytro SHEVCHUK

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 of «31» 08 2021.

Guarantor of Educational and
Professional Program _____ Iryna VYSOTSKA
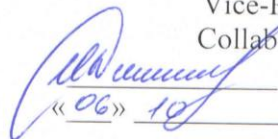
Head of the Department _____ Dmytro SHEVCHUK

Vice-Rector on International
Collaboration and Education
_____ Iryna ZARUBINSKA
«06» 10 2021

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**Master copy**

## CONTENTS

## INTRODUCTION

Course Training Program on «Intelligent Technologies on Transport» is developed on the basis of the "Methodical guidance for the subject course training program for full-time of education", approved by the order №249/роз dated 29.04.2021 and corresponding normative documents..

## Explanatory notes

1.1. Place, aim, objectives of the subject

This subject is a component of the theoretical basis of knowledge and skills for the study of technological subject for training in the field of transportation organization and transport management.

**The aim** teaching the subject is the formation of students' knowledge and skills in the field of intelligent technologies for managing complex transport systems and processes, as well as the application in practice of intelligent automated information support systems for decision making.

**Tasks** the study of the discipline is:

- obtaining knowledge about modern ones theoretical concepts, categories, systems and processes of intellectual management transport systems and processes;

- mastering modern methods and approaches to intelligent management transport systems and processes;

- obtaining knowledge about modern ones directions of development of intelligent systems (modeling of knowledge bases and knowledge management, fuzzy logic, neurotechnologies, neurofuzzy technologies, genetic and evolutionary control algorithms, expert systems);

- mastery practical skills of solving problems on designing intelligent decision support systems in conditions of uncertainty;

- mastering modern methods of synthesis of distributed intelligent systems for diagnosing and managing SCADA.

1.2. Results of mastering the training course

− Search for the necessary information in the scientific and technical literature, databases, other sources, analyze and objectively evaluate information in the field of transport systems and technologies and related interdisciplinary issues;

− Freely discuss in state and foreign languages issues of professional activity, projects and research in the field of transport systems and technologies orally and in writing;

− Make effective decisions in the field of transport systems and technologies, taking into account technical, social, economic and legal aspects, generate and compare alternatives, assess the necessary resources and constraints, analyze risks;

− Develop new and improve existing transport systems and technologies, define development goals, existing constraints, efficiency criteria and scope;

− Manage complex technological and production processes of transport systems and technologies, including unpredictable and those that require new strategic approaches;

− Use specialized software for analysis, development and improvement of transport systems and technologies;

− Present the results of research activities, prepare scientific publications, participate in scientific discussions at scientific conferences, symposia and carry out pedagogical activities in educational institutions.

1.3. Competencies of mastering the training course

− Ability to work in an international context;

− Ability to search, process and analyze information from various sources;

− Ability to develop and manage projects;

− Ability to generate new ideas (creativity);

− Ability to research and manage the operation of transport systems and technologies;

− Ability to use specialized software to solve complex problems in the field of transport systems and technologies;

− Ability to apply modeling and optimization methods to study and improve the efficiency of air transport systems and their management processes.

1.4. Interdisciplinary connections.

This course is based on knowledge of such subjects as: «Methodology of Applied Research in the Field of Transport Technologies (by modes)», «Project Management on Transport Industry», «Management in Integrated Transport Systems» and is the basis for study such subjects as: «Forwarding Activity», «Air Transportation Engineering», «Mathematical Methods of Modeling and Optimization of Transport Systems and Processes», «Course Project " Project Management on Transport Industry ".

## 2. ACADEMIC CURRICULUM OF THE SUBJECT

2.1. Content of the subject

The educational material of the discipline is structured on a modular principle and consists of one educational module, namely:

- training module № 1 "Intelligent control of transport systems and processes", which is a logically complete, relatively independent, integral part of the discipline, the mastering of which involves a modular test and analysis of the results of its implementation.

2.2. Modular structuring and integrated requirements for each module

**Module № 1** "Intelligent control of transport systems and processes"

Integrated requirements of module №1:

**Know** modern theoretical concepts, categories, systems and processes of intellectual managementtransport systems and processes; modern methods and approaches to intelligent managementtransport systems and processes; modern directions of development of intelligent systems (modeling of knowledge bases and knowledge management, fuzzy logic, neurotechnologies, neurofuzzy technologies, genetic and evolutionary control algorithms, expert systems);

**Be able to** solve problems on designing intelligent decision support systems in conditions of uncertainty; apply modern methods of synthesis of distributed intelligent systems for diagnosing and controlling SCADA.

**Topic 1.** Intelligent control systems for transport systems and processes.

The purpose and objectives of the study of the discipline "Intelligent Control Systems". Levels of intellectualization of transport systems. Principles of building intelligent control systems. Development of the technical task. Architecture design of intelligent control systems. Requirements to be considered when designing integrated intelligent control systems.

**Topic 2**. Modern intelligent technologies for managing transport systems and processes.

Areas of research in the field of intelligent technologies. Classification of intelligent technologies and systems. The concept of intelligent information technology. Properties of knowledge. Classification of knowledge. Classification of knowledge bases. Architecture of intelligent control systems.

**Topic 3**. Development of structural and functional schemes of integrated intelligent control systems.

Rules for the development of structural schemes of control and management. Methodology and general principles of execution of functional schemes of integrated intelligent control systems of technological processes on transport. Requirements for the design of functional diagrams of intelligent control systems in transport.

**Topic 4.** Intelligent decision support systems.

Organization of dialogue between man and intelligent transport system. Structural and functional schemes of construction of integrated intelligent control systems on transport. Principles of building decision support systems in transport systems.

**Topic 5.** Principles of building intelligent control systems.

Principles of system approach. Principles of economic and mathematical nature. Principles of systemic nature. Organizational and technical principles. Substantiation of control algorithms of integrated intelligent complex control systems. Software development. Scheme of information flows of integrated intelligent integrated transport management systems. Development of screen forms of integrated integrated transport control systems.

**Topic 6**. Expert management systems for transport complexes.

Classification of expert control systems for transport complexes. Typical structures of expert management systems of transport complexes. Methods and stages of development of expert management systems of transport complexes. Determination of dynamic characteristics of control objects. Calculation and adjustment of defining parameters of functioning of intelligent control and management systems.

**Topic 7.** Algorithmic support of intelligent control of equipment of technological transport processes.

A typical algorithm for controlling the transport process. Operational diagnosis of the state of technological equipment using intelligent technologies. Algorithm of operative diagnosis with the use of intelligent technologies. System integration tools. Levels of solving design problems. Application packages.

**Topic 8.** Fuzzy logic. Neuro-fuzzy control systems for transport systems and processes.

The concept of fuzzy set, linguistic change, membership function. channel and communication line. The concept of signal and signal carrier. Deterministic and random signals. Signal modulation and coding. Multichannel communication systems. Principles of interfaces. Fuzzy methods software. Structural and functional schemes of fuzzy regulators. Stages of information processing in fuzzy regulators. Methods for optimizing the processing of fuzzy information.

Methods of architectural and system design of neuro-fuzzy control systems. Synthesis of the optimal technical structure of neuro-fuzzy control systems of complex transport systems and processes. Methods of teaching with a teacher (controlled learning). Methods of teaching without a teacher (uncontrolled learning). Backpropagation algorithm. Methods of forming training, test and control samples.

## 2.3. Structure of the subject

| № | Theme | Total, hours | | | |
|---|---|---|---|---|---|
| | | Total | Lectures | Labs | Self-study |
| 1 | 2 | 3 | 4 | 5 | 6 |
| *Module №1 «Intelligent control of transport systems and processes»* | | | | | |
| 1.1. | Intelligent control systems for transport systems and processes. | 13 | 2 | 2 | 9 |
| 1.2 | Modern intelligent technologies for managing transport systems and processes. | 13 | 2 | 2 | 9 |
| 1.3 | Development of structural and functional schemes of integrated intelligent control systems. | 13 | 2 | 2 | 9 |
| 1.4 | Intelligent decision support systems. | 13 | 2 | 2 | 9 |
| 1.5 | Principles of building intelligent control systems. | 13 | 2 | 2 | 9 |
| 1.6 | Expert management systems for transport complexes. | 14 | 2 | 2 | 10 |
| 1.7 | Algorithmic support of intelligent control of equipment of technological transport processes. | 13 | 2 | 2 | 9 |
| 1.8 | Fuzzy logic. Neuro-fuzzy control systems for transport systems and processes. | 16 | 2 2 | 2 | 10 |
| 1.9 | Module test №1 | 12 | - | 2 | 10 |
| **Total by the module №1** | | 120 | 18 | 18 | 84 |
| **Total by the Subject** | | 120 | 18 | 18 | 84 |

## BASIC CONCEPTS OF GUIDANCE ON THE SUBJECT

3.1. Teaching methods

The following teaching methods in subject guidance are:

- explanatory and illustrative method;
- method of problem presentation;
- reproductive method;
- research method.

The implementation of these methods are carried out during lectures, demonstrations, self-study, work with the educational material, analysis and solving problems in assessing information technologies on transport.

3.2. List of references (basic and additional)

Basic literature

3.2.1. Fuzzy Logic Applications in Engineering Science/ Harris, J, 2020. – 400p.

3.2.2. Kingdom J. Intelligent Systems / J. Kingdom. – Berlin: Springer–Verlag, 2015. – 227 p

3.2.3. Intelligent Hybrid Systems: Fuzzy Logic, Neural Networks, and Genetic Algorithm / Ed. by Da Ruan. – Boston : Kluwer Academic Publishers, 2019. – 258 p.

3.2.4. Інтелектуальні системи підтримки прийняття рішень : навч. посіб. / Б. М. Герасимов, В. М. Локазюк, О. Г. Оксіюк, О. В. Поморова ; Європ. університет. – Київ, 2017. – 335 с

3.2.5. Ковальчук К. Ф. Оцінка ефективності інформаційно-інтелектуальних технологій / К. Ф. Ковальчук, Л. М. Бандоріна, Л. М. Савчук. – Дніпропетровськ : ІМА-прес, 2018. – 132 с.

3.2.6. Столяревська А. Л. Інтелектуальні системи : навч. посіб. / А. Л. Столяревська, Ю. О. Кузнєцов ; Нац. техн. ун-т "Харків. політехн. інститут". – Харків, 2007. – 284 с

3.2.7. Щокін В. П. Інтелектуальні системи керування: аналітичний синтез та методи дослідження / В. П. Щокін. – Кривий Ріг : Д.О. Чернявський, 2018. – 264 с.

3.2.8. Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems By Guanrong Chen, Trung Tat Pham, 2019. – 368 p.

Additional Literature

3.2.9. Гороховський О. І. Інтелектуальні системи / О. І. Гороховський ; Вінниц. нац. техн. університет. – Вінниця, 2015. – 193 с.

3.2.10. Кирик В. В. Комп'ютерно-інтегровані технології управління на основі нечіткої логіки / В. В. Кирик ; Акад. муніцип. управління. – Київ, 2008. – 198 с.

3.2.11. Створення мікроелектронних датчиків нового покоління для інтелектуальних систем / Я. І. Лепіх, Ю. О. Гордієнко, С. В. Дзядевич . – Одеса : Астропринт, 2020. – 256 с.

3.2.12. Neural Networks for Control and Systems / Ed. by K. Warwick – London: Peregrinus, 2018. – 260 p.

3.2.13. Cichocki A., Unbehauen R. Neural Networks for Optimization and Signal Processing / A. Cichocki, R. Unbehauen. – Stuttgart: Teubner, 1993. – 526 p.

3.3 Internet resources

3.3.1. Сайт розробника інтелектуальних систем / [Електронний ресурс]. - Режим доступу: https://www.sites.google.com/site/upravlenieznaniami/intellektualnye-informacionnye-sistemy-v-upravlenii-znaniami

3.3.2. Сайт «Українські інтелектуальні системи (UIS)» / [Електронний ресурс]. - Режим доступу: https://uislab.com/

3.3.3. Авторські керівництва та довідкові матеріали по роботі з продуктами MathWorks [Електронний ресурс]. - Режим доступу: http://matlab.exponenta.ru

3.3.4. Сторінка сайту МФТІ, присвячена математичному моделюванню транспортних потоків / [Електронний ресурс]. - Режим доступу: https://mipt.ru/education/chair/computational_mathematics/upload/22b/Book-arpglktefbb.pdf

3.3.5. Сайт розробника Matlab (MathWorks.) / [Електронний ресурс]. - Режим доступу: www.matlab.com

## 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 | Maximum Grade Values |
|---|---|
| | **Module №1** |
| **1 semester** | |
| Carrying out labs. | 80 points (total) |
| For admission to complete module test №1, a student must receive not less than | 48 points |
| Module test  №1 | 20 points |
| **Total for the Module №1** | **100** |
| **Total for the subject** | **100** |

4.8. The Total Semester Grade is entered into the Examination Register and into a student's record book in grades, National Scale grades, and ECTS Scale grades.

4.9. The Total Semester Grade is entered into a student's record book, for example: ***92/Ex/A,  87/Good/B, 79/Good/C,  68/Sat/D,  65/Sat/E,*** etc.

4.10. The Total Grade for completing and defensing of the Term Paper is entered into a student's record book, for example: ***92/Ex/A,  87/Good/B,  79/Good/C,  68/Sat/D,  65/Sat/E,*** etc.

4.11. 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.

The Total Grade is recorded to the Diploma Appendix.

(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 | | | | |