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**NATIONAL AVIATION UNIVERSITY**  
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 « 06 » 2021



Quality Management System

**COURSE TRAINING PROGRAM**

on

**"Statistical analysis of transport systems and processes"**

Educational 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:	4	150/5,0	34	—	34	82	—	CP-4s	examination 4s

Index: CB-7-275-1/21-2.1.26

**QMS NAU CTP 19.01–01–2021**



Quality Management System  
Course Training Program on  
«Statistical analysis of transport systems and  
processes»

Document  
Code

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CTP 19.01 – 01-2021

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Course Training Program on «Statistical analysis of transport systems and processes» is developed on the basis of Educational Professional Program «Air Transportation Management», Bachelor Curriculum and Bachelor Extended Curriculum №CB-7-275-1/21 and №ECB-7-275-1/21 for Speciality 275 «Transport Technologies», Specialization 275.04 «Air Transport Technologies» and corresponding normative documents.

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## INTRODUCTION

Course Training Program of academic discipline "Statistical analysis of transport systems and processes" is developed based on the "Methodical recommendations for development and design of the course training program for full-time and part-time forms of education", approved by the order № 249 dated 29.04.2021 and corresponding normative documents.

### 1. EXPLANATORY NOTES

#### 1.1. Place, objectives, tasks of the subject.

This academic discipline determines the level of general scientific training of bachelors of technical and economic specialties. Currently, it is widely used in the economics of air transportation. On the basis of its methods it is possible to study quantitative characteristics of processes, to get more detailed representations of phenomena character, and also to get parameters for realization of economic calculations for the purpose of forecasting.

**The objective** of the subject is highlight the modern methods of applied statistics, which should be sufficient to develop mathematical and econometric models that arise and are used by analysis of transport systems and processes, to process statistical data related practical activities of air transport specialists.

**The tasks** of the subject are:

- mastering the necessary theoretical knowledge of probability theory, mathematical statistics and the basic principles of their application in the system of subjects in training in the specialty 275 «Air Transport Technologies»
- mastering the knowledge and skills of using the MS Excel package required for statistical analysis and modeling of random phenomena in transport systems and processes;
- instill skills of mathematical research of statistical data processing problems;
- develop the ability to independently use the necessary methods and special literature on applied statistics when solving problems and processing statistical data.

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

As a result of studying the discipline student should have the following learning outcomes:


- apply 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;
- formulate, modify, develop new ideas for improving transport technologies;
- evaluate the parameters of traffic flows. Design schemes and networks of transport systems.
- develop technologies for operational management of traffic flows;
- develop, design, manage projects in the field of transport systems and technologies.

#### 1.3. Competences the subject makes it possible to acquire.

- Skills on use of information and communication technologies;
- Ability to evaluate and ensure ergonomic efficiency of transport technologies;
- Ability to evaluate plans and proposals for the organization and technology of transportation, performed by other developers and make the necessary changes based on the technical and operational parameters and principles of operation of facilities and devices of transport infrastructure, vehicles.

#### 1.4. Interdisciplinary connections.

The subject is based on following subjects: "Higher mathematics", "Information Technology on Transport" and is base for studying the following subjects: "Operations Research on Transport", "Technical and Economic Research of Transport Development", "Mathematical Methods of Modeling and Optimization of Systems and Processes".

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## 2. COURSE TRAINING PROGRAM ON THE SUBJECT

### 2.1. The subject content.

Training material is structured according to module principle and consists of two educational module, namely:

– **Module №1 «Basics of Applied Statistics»,**

– **Module № 2 «Analysis of variance. Correlation - Regression Analysis»,** each of which is logically complete, relatively independent, holistic part of the subject, learning of which provides module test and analysis of its performance.

A separate third module (educational component) is a Term Project (TP), that is performed in the fourth semester. TP is an important component of consolidation and deepening the theoretical and practical knowledge and skills acquired by students in the process of mastering the subject educational material.

### 2.2. Modular structuring and integrated requirements for each module.

#### Module №1 «Basics of Applied Statistics»

##### Integrated requirements to module №1:

##### Know:

- concept of a random event and a random variable;
- basic concepts of probability and properties of probability;
- combinatorics formulas; Venn diagrams;
- basic probability theorems: addition, multiplication, total probability, Bayes' theorem;
- representations of random variables and their main characteristics;
- most commonly used distribution laws of random variables and their numerical characteristics;
- representations of the system of several random variables and their numerical characteristics;
- concept of sampling and methods of its formation;
- methodology of point and interval estimates for numerical characteristics of population.

##### Be able:

- calculate the probability of random events based on definitions and theorems
- analyze the laws of distribution and calculate characteristics of random variables;
- analyze the laws of distribution and calculate characteristics several random variables system;
- to carry out primary processing of statistical data, determine point and interval estimations of numerical characteristics.

##### Have skills:

- use of MS Excel package for analysis of probabilistic processes and statistical data processing.

#### Topic 1. Statistical observations. Random events.

Subject and tasks of the subject "Statistical analysis of transport systems and processes". A brief historical background of the development of the concepts of probability theory and mathematical statistics. The role of random phenomena in the study of transport systems and processes. Statistical databases.

Stochastic experiment. Trial. Elementary events. Random events. Operations with events. Venn diagrams.


#### Topic 2. Concept of probability. Probability addition theorem.

The classical definition of probability. Hypothesis of equal probability, its shortcomings. Basic formulas of combinatorics and probability calculation. Frequency of event, its properties. Statistical definition of probability, its shortcomings. Axiomatic definition of probability. Probability addition theorem.

#### Topic 3. Conditional probabilities. Probability multiplication theorem.

Conditional events and conditional probabilities. Properties of conditional probabilities. Probability multiplication theorem. Independent events. Total probability formula. Bayesian formula. A priori and a posteriori probabilities.



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#### **Topic 4. Random variables and their distributions.**

Random variables. Discrete and continuous random variables. Probability distribution law of a discrete random variable. Analytical, tabular and graphical representation of probability distribution law. Probability distribution function of a random variable and its properties. Probability distribution function of a discrete random variable. Distribution density of a continuous random variable.

#### **Topic 5. Numerical characteristics of random variables distributions.**

Mathematical expectation for discrete and continuous random variables and its properties. Central moments of random variables. Variance of a random variable, its properties. The standard deviation. Other numerical characteristics of the distribution of a random variable: mode, median, asymmetry, excess. Basic distribution laws of discrete and continuous random variables: binomial, Poisson, geometric, hypergeometric, uniform, exponential, normal, etc.

#### **Topic 6. Systems of random variables. Conditional laws of distribution of random variables.**

The concept of a system of several random variables. Probability distribution law of a discrete two-dimensional random variable. Distribution function of two-dimensional random variable. The density of the joint probability distribution of a continuous two-dimensional random variable. Marginal distributions. Numerical characteristics of a system of several random variables. Conditional distribution laws of components of the system of random variables. Dependent and independent random variables. Correlation moment and correlation coefficient. Correlation and dependence of random variables.

#### **Topic 7. Basics of sampling method.**

Population and sample. Estimation of numerical characteristics of random variables. Estimation of distribution function and density. Variational series, polygon and histogram. Absolute, relative and average values. Measures of variability: range, variance, standard deviation, coefficient of variation.

The law of large numbers. Chebyshev's inequality. Glivenko's theorem.

#### **Topic 8. Statistical parameters- estimations.**

The concept of statistics. Estimation methods and their properties: Properties of statistical estimates: unbiasedness, validity, efficiency. Methods of point estimation: method of moments, method of maximum likelihood. Point estimates of expectation, variance, probability of a random event.

The concept of confidence interval. Confidence intervals for normal samples.

### **Module № 2 «Analysis of variance. Correlation - Regression Analysis»**


#### **Integrated requirements to module №1:**

##### **Know:**

- main types of statistics and their properties;
- rules for constructing criteria for testing statistical hypotheses;
- methodology for testing the main hypotheses regarding the general mean and variance;
- methodology for testing the hypothesis of the distribution law ( $\chi^2$  - Pearson's consistency criterion);
- stages of one-factor and two-factor analysis of variance;
- least squares method;
- methodology of correlation and regression analysis;
- method of dummy variables;
- classic time series schedules.

##### **Be able:**

- to perform computer calculations of parameters of models of one-factor and two-factor analysis of variance and correctly interpret the obtained results;
- to choose reasonable forms of regression models to determine the nature of dependencies between values;

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- to perform computer calculations of pairwise and multiple regression coefficients;
- to highlight the trend of the time series;
- to analyze the impact of seasonality on air transportation.

#### **Have skills:**

- use of MS Excel package in analysis of variance, correlation and regression..

#### **Topic 1. Statistical hypotheses.**

Statistical hypotheses testing. Examples of application statistical hypotheses testing by the analysis of transport systems and processes. Types of hypotheses. Parametric statistical hypotheses. Statistical criterion. Critical region and region of hypothesis acceptance. Errors of the first and second kind. The level of significance of the criterion. The power of the criterion.

#### **Topic 2. Statistical hypothesis testing.**

Hypothesis testing for means. Hypothesis test for equality of two population means. Hypothesis test for equality of two variances. Testing of statistical hypotheses about the distribution law (criterion  $\chi^2$  - Pearson's consistency criterion).

#### **Topic 3. Statistical tests of nonparametric hypotheses.**

Nonparametric test. Wilcoxon-Mann - Whitney test. Sign test. Pairwise Wilcoxon rank sum tests.

#### **Topic 4. Design of experiment and analysis of variance.**

The basic idea of an analysis of variance. One-way analysis of variance. Two-factor analysis of variance.

#### **Topic 5. Correlation and regression dependences.**

Functional, statistical and correlation dependencies. Simple linear regression. Least squares method and its properties. Nonlinear regression.

#### **Topic 6. Multiple linear regression.**

Multiple regression. Multiple correlation and regression coefficients.

#### **Topic 7. Various aspects of multiple regression.**

Regression with respect to normalized variables. Elasticity coefficients. Linear regression models with variable structure. Dummy variables. Seasonality modeling.

#### **Topic 8. Basics of time series theory.**

The concept of time series. Stationary time series. Classical time series decomposition method. Numerical characteristics of time series: mathematical expectation, variance, autocovariance, autocorrelation.

#### **Topic 9. Statistical analysis of air transportation problems.**

Quantitative characteristics of the dynamics of air transportation in Ukraine. Methods of allocating the trend of the time series. Analysis of the impact of seasonality on air transportation.

### **Module № 3 (educational component) "Course project"**

The course project (CP) is implemented in the fourth semester, in accordance with the approved guidelines. It is needed for consolidate and deepen the theoretical knowledge and skills acquired by the student in the process of mastering all the material of the subject.


Execution of CP is an important element of student preparation for the theoretical and project parts of the thesis.

The purpose of the course project is to acquire students the following skills:

- apply methods of statistical analysis to study transport processes, models which are based on real observations;
- use MS Excel to solve application problems.

Execution, registration and protection of CP is carried out by the student individually according to methodical recommendations.

The time required to complete the CP is 45 hours of individual work.

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### 2.3. Training schedule of the subject.

№ пор	Theme (thematic section)	Total, hours			
		Total	Lectures	Labs	Self-study
1	2	3	4	5	6
<b>Module №1 «Basics of Applied Statistics»</b>					
1.1	Statistical observations. Random events.	<b>4 semester</b>			
		6	2	2	2
1.2	Concept of probability. Probability addition theorem.	6	2	2	2
1.3	Conditional probabilities. Probability multiplication theorem.	6	2	2	2
1.4	Random variables and their distributions.	6	2	2	2
1.5	Numerical characteristics of random variables distributions.	6	2	2	2
1.6	Systems of random variables. Conditional laws of distribution of random variables.	6	2	2	2
1.7	Basics of sampling method.	6	2	2	2
1.8	Statistical parameters estimations.	4	2	-	2
1.9	Module Test №1.	3	-	2	1
<b>Total by module №1</b>		<b>49</b>	<b>16</b>	<b>16</b>	<b>17</b>
<b>Module № 2 «Analysis of variance. Correlation - Regression Analysis»</b>					
2.1	Statistical hypotheses.	6	2	2	2
2.2	Statistical hypothesis testing.	6	2	2	2
2.3	Statistical tests of nonparametric hypotheses.	6	2	2	2
2.4	Design of experiment and analysis of variance.	6	2	2	2
2.5	Correlation and regression dependences.	6	2	2	2
2.6	Multiple linear regression.	6	2	2	2
2.7	Various aspects of multiple regression.	6	2	2	2
2.8	Basics of time series theory.	6	2	2	2
2.9	Statistical analysis of air transportation problems.	4	2	-	2
2.10	Module Test №2.	4	-	2	2
2.11	Test (homework) (part-time education)	-	-	-	-
<b>Total by module №2</b>		<b>56</b>	<b>18</b>	<b>18</b>	<b>20</b>
<b>Module № 3 "Course project"</b>					
3.1	Statistical analysis and forecasting of dynamics dynamics of air passenger transportation.	45	-	-	45
<b>Total by module №3</b>		<b>45</b>	<b>-</b>	<b>-</b>	<b>45</b>
<b>Total by subject</b>		<b>150</b>	<b>34</b>	<b>34</b>	<b>82</b>


## 3. EDUCATIONAL AND METHODOLOGICAL MATERIALS ON SUBJECT

### 3.1. Teaching methods

The following teaching methods of subject guidance are

- explanatory and illustrative method;
- method of problem presentation;



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- reproductive method;
- research method.

The implementation of these methods are carried out during lectures, demonstrations, self-study, work with the educational material, analysis of transport technologies issues.

### 3.2. List of references (basic and additional)

#### Basic literature

3.2.1. Барковський В. В. Теорія ймовірностей та математична статистика / В. В.Барковський, Н. В. Барковська, О. К. Лопатін. - 5-те видання. - К. : ЦУЛ, 2014. - 424 с.

3.2.2. Berenson M.L., Levine D.M., Krehbiel T.C. Basic Business Statistics: Concepts and Applications, 12th ed. – Prentice Hall, 2013. – 859 p.

#### Additional Literature

3.2.3. Жлуктенко В. І., Наконечний С. І. Теорія ймовірностей і математична статистика: Навч.-метод. посібник. У 2 ч. – Ч. II. Математична статистика. . – К.: КНЕУ, 2014. – 336 с.

3.2.4. Руденко В. М. Математична статистика. Навч. посіб. – К.: ЦУЛ, 2016. – 304 с.

3.2.5. Walpole R.E. Probability and Statistics for Engineers and Scientists / R.E. Walpole, R.H. Myers, S.L. Myers and K.E. Ye., 9th ed. – Pearson, 2014. –791p..

### 3.3. Internet Information resources

3.3.1 <https://msoffice-prowork.com/ref/excel/excelfunc/>

3.3.2. <https://excel2.ru/>

3.3.3. <https://data.worldbank.org/indicator/IS.AIR.PSGR?end=2019&locations=UA>

3.3.4. <https://avia.gov.ua/pro-nas/statistika/periodychna-informatsiya/>


3.3.5. <https://www.worlddata.info/europe/ukraine/tourism.php>

## 4. RATING SYSTEM OF STUDENTS' 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	Kind of Academic Work	Maximum Grade Values
<b>4-5 semesters</b>			
<b>Module №1 «Basics of Applied Statistics»</b>		<b>Module № 2 «Analysis of variance. Correlation - Regression Analysis»,</b>	
Kind of academic work	Max Grade	Kind of academic work	Max Grade
Carrying out and defending labs № 1-7 (4G x 7)	28 (total)	Carrying out and defending labs (3G x 8)	24 (total)

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<i>For admission to complete module test №1, student must receive not less then</i>	<i>17 grades.</i>	<i>For admission to complete module test №1, student must receive not less then</i>	<i>15 grades.</i>
Compliting Module Test №1	12	Compliting Module Test №2	16
<b>Total by the module №1</b>	<b>40</b>	<b>Total by the module №2</b>	<b>40</b>
<b>Total by module №1, №2</b>			<b>80</b>
<b>Examination</b>			<b>20</b>
<b>Total by subject</b>			<b>100</b>
<b>Module №3 «Course project»</b>			
Kind of academic work	Max Grade		
Completion of the course project	60		
Defense of the course project	40		
<b>Execution and defense of the course project</b>	<b>100</b>		

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.

The Total Grade is recorded to the Diploma Appendix.

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(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 ознайо- млення	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				