(Ф 03.02 – 101)

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
Aerospace Faculty
Department of Engineering, Standardization and Certification

APPROVED
Vice-Rector for Academics
_____ A. Gudmanian
«___»_____2020

Quality Management System

COURSE TRAINING PROGRAM

on
«Metrology and Standardization»

Field of study: 27 «Transport»
Speciality: 272 «Aviation Transport»
Educational Professional Programs: «Maintenance and Repair of Aircraft and Aircraft Engines»
«Airports Technologies and Technological Equipment»

Year of study – 2nd Semester – 3d

Lectures – 17 Graded Test – 3d semester
Laboratory Classes – 17
Self-study – 56
Total (hours/ECTS credits) – 90/3

Index ECB- 1- 2- 272/18 – 2.1.7.7
ECB-1-2-272/18- 2.1.8.6
ECB-1-2-272/18 – 2.1.12.7

QMS NAU CTP 07.05-01-01-2020

The Course Training Program on «Metrology and Standardization» is developed on the basis of the Bachelor Extended Curriculums ECB- 1- 2- 272/18, ECB-1-2-272/18, ECB-1-2-272/18 for Speciality 272 «Aviation Transport» Educational Professional Programs «Maintenance and Repair of Aircraft and Aircraft Engines», «Airports Technologies and Technological Equipment», Ukrainian version of the Course Training Program on «Metrology and Standardization» index РБ -1- 2- 272/18 – 2.1.7.7, РБ-1-2-272/18- 2.1.8.6, РБ-1-2-272/18 – 2.1.12.7 approved 19.02.2020, corresponding normative documents.

Developed by:

Senior lecturer of
Department of Engineering,
Standardization and Certification _____ I. Semak
Associate professor of
Department of Engineering,
Standardization and Certification _____ O. Bashta

Discussed and approved by Department of Engineering, Standardization and Certification, Minutes № __ of _____2020.
Head of the Department _____M. Kindrachuk

Discussed and approved by the Graduate Department for Speciality 272 «Aviation Transport» Educational Professional Programs «Maintenance and Repair of Aircraft and Aircraft Engines» Aircraft Airworthiness Retaining Department, Minutes № __ of _____2020.
Head of the Department _____ O. Popov

Discussed and approved by the Graduate Department for the Speciality 272 "Aviation Transport" and Educational Professional Program “Airports Technologies of Works and Technological Equipment” Airport Technologies Department, Minutes № _____ of _____2020.
Head of the Department _____ O.Tamargazin

“Agreed”
Dean of Aerospace Faculty

_____ Yu. Ziatdinov
«___»_____2020

“Agreed”
Director of the Institute of Innovative Technologies and Leadership
_____ K. Babikova
«___» _____2020

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Contents

INTRODUCTION

The Course Training Program of the subject "Designing of Machines and Mechanisms and Fundamentals of Interchangeability" is developed on the basis of the "Methodical guidance for the development of a course training program of the subject", approved by the order №106/роз dated 13.07.2017 and corresponding normative documents.

1. Explanatory notes

1.1. Planned results.

The course "Metrology and Standardization" is the theoretical basis of a set of knowledge and skills that form students' knowledge of methods of ensuring the accuracy and uniformity of measurements inherent in future professional activity, in accordance with the requirements of standards and other normative documents.

The overall focus of the discipline is to study the basic provisions of metrology and to observe them when performing measurements and presenting the results of measurements.

The purpose of teaching the discipline is to develop students' knowledge of the basics of measuring and controlling physical quantities, according to metrological requirements and presenting them in the relevant documentation.

The task objective of studying the discipline is:
studying basis of metrology and measurement skills inherent in professional activity.

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

- ability to use the requirements of regulatory and legal metrology documents;
- ability to apply physical quantities and the basics of their measurements, as well as the application of basic measurement methods and techniques;
- ability to use the basics of statistical processing of experimental measurement data;
- ability to have methods of ensuring accuracy and uniformity of measurements;
- ability to detect possible errors in measurement results and ways of presenting them.

Academic discipline “Metrology and Standardization" is based on the knowledge got during studying the disciplines: "Higher Mathematics", "Physics" "Electrical Engineering and Electronics", "Descriptive Geometry and Engineering Graphics" and is the basis for the study of such disciplines as: "Materials Science" "Theory of Mechanisms and Machines", "Details of Machines", "Design of Functional Aircraft Systems", "Hydraulics and Hydropneumatic Devices” of Aviation Engineering", "Theory and Calculations of Automotive Engineering", "Airport Engineering".

1.2. Educational Subject Program

The subject matter of discipline is structured with module principle and is divided into two modules.

Training **module №1 „Fundamentals of Metrology”,** training **module № 2 „ Fundamentals of Standardization”**, each of which is logically complete, relatively independent, integral part of the discipline, learning of which provides for modular test and analysis of its doing.

Module №1 "Fundamentals of Metrology";

Topic 1. Metrology is the science of measurement. Basic concepts and definitions in metrology. The importance of metrology for scientific and technological progress. State metrological organizations. International and national standards in the field of metrology.

Topic 2. Physical quantities and their units. Physical quantities and bases of their measurements. International System of Units SI. Basic and derived units of the SI system. Multiple and partial units.

Topic 3. Measurement principles and methods. Measurement errors of physical quantities. Basic concepts of measurement. Classification of measurements. Electrical methods for measuring non-electrical quantities. Measurement errors. Random errors. Evaluation of the true value of the measurement value. Mathematical processing of measurement results.

Topic 4. Measuring instruments and their errors. Characteristics of measuring instruments. Measurement equipment errors. Classification of measuring instruments.

Topic 5. Standards and reference measuring instruments. General concepts about standards. Classification of standards. Measuring equipment. General information about verification schemes. Methods of calibration of measuring equipment.

Topic 6 Methods for improving measurement accuracy. Measurement error analysis. Method of stabilization of static characteristics parameters. Structural redundancy method. Method of reducing random and systematic components of errors.

Topic 7 State Metrological Service of Ukraine. Metrological ensuring uniformity of measurements. The main tasks of metrological support. Structure of the metrological service of Ukraine. Metrological Services of Central Executive Bodies, Enterprises and Organizations. Departmental Metrological Service. State metrological control and supervision. State testing of measuring instruments. Verification, audit and expertise of measuring instruments.

Module № 2 „ Fundamentals of Standardization".

Topic 1. The main provisions, the goal and objectives of standardization. Basic concepts of standardization. The purpose and objectives of standardization.

Topic 2. Principles and methods of standardization. Categories of standardization documents. Methods of standardization. Advance and comprehensive standardization.

Topic 3. State standardization system of Ukraine. National standardization system. Standardization bodies of Ukraine. Departmental standardization service. Principles of application of standards. State oversight of standards. Normal control of technical documentation.

Topic 4. Types and categories of standards and regulations. Types and categories of standards. Procedure for developing, adopting, amending and revising standards. Procedure for approval and implementation of standards.

Topic 5. Systematization of general technical standards. System of design and technological documentation.

Topic. 6. International standards ISO 9000 and ISO 10000 series. Composition of the ISO 9000 and ISO 10000 standards. Requirements containing the ISO 9000 series standards.

2. CONTENT OF THE SUBJECT

2.1. Subject structure.

SN	Topic	Academic Hours			
		Total	Lectures	Practices	Self-study
Semester 3					
Module №1 "Fundamentals of Metrology"					
1.1	Metrology as a science of measurement. Physical quantities and their units.	9	2	2	5

1.2	Principles and methods of measurement. Errors of measurement of physical quantities. Means of measuring equipment and their errors.	10	2	2	6
1.3	Standards and exemplary measuring instruments.	10	2	2	6
1.4	Methods of increasing accuracy of measurements.	10	2	2	6
1.5	State Metrology Service of Ukraine.	7	2	-	5
1.6	Module Test № 1	6	-	2	4
Total for Module № 1		**52**	**10**	**10**	**32**
Module №2 "Fundamentals of Standardization"					
2.1	Main provisions of the purpose and tasks of standardization. Principles and methods of standardization.	9	2	2	5
2.2	The State Standardization System of Ukraine. National System of Standardization.	10	2	2	6
2.3	Types and categories of standards and regulations. Systematization of general technical standards.	9	2	2	5
2.4.	International standards of the ISO 9000 series and ISO 10000.	6	1		5
2.4	Module Test № 2	4	-	1	3
Total for Module № 2		**38**	**7**	**7**	**24**
Total for the Subject		**90**	**17**	**17**	**56**

2.2. Lectures: themes and hours

№	Topic	Academic Hours	
		Lectures	Self-Study
1	2	3	4
3 semester			
Module№1 "Fundamentals of Metrology"			
1.1	Metrology as a science of measurement. Physical quantities and their units.	2	3
1.2	Principles and methods of measurement. Errors of measurement of physical quantities. Means of measuring equipment and their errors.	2	3
1.3	Standards and exemplary measuring instruments.	2	3
1.4	Methods of increasing accuracy of measurements.	2	3
1.5	State Metrology Service of Ukraine.	2	5
Total for the module №1		**10**	**17**
Module № 2 "Fundamentals of Standardization"			
2.1	Main provisions of the purpose and tasks of standardization. Principles and methods of standardization.	2	3
2.2	The State Standardization System of Ukraine. National System of Standardization.	2	3

2.3	Types and categories of standards and regulations. Systematization of general technical standards.	2	3
2.4	International standards of the ISO 9000 series and ISO 10000.	1	5
Total for the module №2		**7**	**14**
Total for the discipline		**17**	**29**

2.3. Laboratory Classes: themes and hours

№	Topic	Academic Hours	
		Laboratory classes	Self study
1	*2*	3	4
3 semester			
Module№1 "Fundamentals of Metrology"			
1.1	Acquaintance with measuring equipment (ME) for product control	2	2
1.2	Statistical processing of direct measurement results	2	3
1.3	Multiple measurement results processing. Evaluation of random measurement errors. Normal law of distribution of random variables	2	3
1.4	Measurement of radial beating of a shaft. Assignment of tolerances and accuracy class of parts	2	3
1.5	Module test № 1	2	4
Total for the module №1		**10**	**15**
Module№ 2 "Fundamentals of Standardization"			
2.1	National standardization system of Ukraine. Law of Ukraine on metrology and metrological activity	2	2
2.2	Types of standards. Procedure for development, approval and implementation of standards	2	3
2.3	Parametric standardization. The basic properties of series of preferred numbers	2	2
2.4	Module test № 2	1	3
Total for the module №2		**7**	**10**
Total for the discipline		**17**	**25**

2.4. Self-study (individual work) of the student, its content and hours

№	Student self-study and its content	Self-Study (Academic Hours)
1	2	3
3 semester		
1.	Studying lecture material	29
2.	Preparation to laboratory classes	18
3.	Preparation to module tests	7
Total for the discipline		**56**

3. EDUCATIONAL AND METHODICAL MATERIALS ON DISCIPLINE

3.1.**Methods of Teaching.** To enhance the educational and cognitive activity of students during the study of the discipline such educational technologies as work in small groups, solving situational tasks, lectures using lectures using multimedia presentations are used.

3.2. Recommended Literature

Basic literature

3.2.1. Закон України про метрологію та метрологічну діяльність №1765-IV від 01.01.2016.

3.2.2. ДСТУ 2681 – 94. Метрологія. Терміни та визначення.

3.2.3. ДСТУ 3651 – 97 Одиниці фізичних величин.

3.2.4. Закон України «Про стандартизацію» від 05.06.2014 № 1315-VII.

3.2.5.Новиков В.М., Коцюба А.М., Величко О.М. Основи метрології та метрологічна діяльність. Навчальний посібник. Частина 1 – Київ: Нора – прінт, 2000. – 228с.

3.2.6.Цюцюра С.В., Цюцюра В.Д. Метрологія основи вимірювань: Навч. посіб. – К.: Знання, 2003. –180 с.

3.2.7.Цюцюра С.В., Цюцюра В.Д. Метрологія основи вимірювань, стандартизація та сертифікація; Навч. Посібн. – К.: Знання, 2005. – 242 с.

3.2.8.Боженко Л.І. Метрологія, стандартизація, сертифікація та акредитація: Навч. посібн. – Львів: Афіша, 2006 -324 с.

3.2.9.Поліщук Є.С., Дорожовець М.М., Яцук В.О та ін.. Метрологія та вимірювальна техніка: Підручник:- Львів: Видавництво «Бескид Біт», 2003. – 544с.

3.2.10. International vocabulary of metrology—Basic and general concepts and associated terms (VIM) (PDF) (3rd ed.). International Bureau of Weights and Measures on behalf of the Joint Committee for Guides in Metrology. 2012. p. 46.

3.2.11. Czichos, Horst; Smith, Leslie, eds. (2011). Springer Handbook of Metrology and Testing (2nd ed.).

Additional literature

3.2.12. Закон України про стандартизацію №1314 від 05.06.2014 року.

3.2.13.ДСТУ 1.5-93 Державна система стандартизації України. Загальні вимоги до побудови, викладу, оформлення та змісту стандартів.

3.2.14. ДСТУ 1.6-97 Державна система стандартизації України. Порядок державної реєстрації галузевих стандартів, стандартів науково-технічних та інженерних товариств і спілок,

3.2.15.Тарасова В.В., Малиновський А.С., Рибак М.Ф. Метрологія, стандартизація і сертифікація. Підручник. – К.: Центр навч літератури, 2006 – 266 с.

3.2.16.Саранча Г.А. Метрологія, стандартизація, відповідність, акредитація та управління якістю. Підручник.-К.: Центр навч. літератури, 2006.-264с.

3.2.17. International Vocabulary of Terms in Legal Metrology (VIML), Bureau International De Métrologie Légale (BIML) Edition 2000, p. 28.

3.2.18. The International System of Units (SI brochure (EN): 8th edition, 2006, p. 28.

3.2.19. Fyk, M., Burova, M., Fyk, I. (2020) - Metrology, certification and standardization. Lecture notes (Ukrainian language). DOI - 10.13140/RG.2.2.30731.85289

3.3. Internet Information resources

3.3.1. https://er.nau.edu.ua/handle/NAU/40476

3.3.2. https://www.me.gov.ua/Documents/Detail?lang=en-GB&isSpecial=True&id=4d124447-546e-4fe8-bc1b-

e1da490da1ee&title=TechnicalRegulationSystemOfUkraine-standardization-ConformityAssessmentAndAccreditation-MetrologyAndMetrologicalActivity-

3.3.3. https://www.cencenelec.eu/research/ForMembers/Why/metrology/Pages/default.aspx

3.3.4. https://www.iso.org/standards.html

4. RATING SYSTEM FOR ASSESSING STUDENTS' KNOWLEDGE AND SKILLS ACQUIRED

4.1. Control methods and points accounting scheme

Grading of different kinds of academic work performed by a student is done in accordance with Table 4.1.

Table 4.1.

Grading of different kinds of academic work performed by a student

3 Semester			
Module №1		**Module №2**	
Academic Activities	Max Grade	Academic Activities	Max Grade
Performance and protection of laboratory works 1.1-1.4 (4x8)	32 (total)	Performance and protection of laboratory works 2.1 – 2.3 (3x10)	30 (total)
*For carrying out module test № 1, a student must receive **not less than 20 values***		*For carrying out module test № 2, a student must receive **not less than 18 values***	
Module test №1	**12**	**Module test №2**	**14**
Total for Module №1	**44**	**Total for Module №2**	**44**
Semester Graded Test			**12**
Total 3-d Semester Score			**100**

4.2. The kind of academic work, performed by a student, has been passed, if a student got positive grade according to National Scale – (see Table 4.2).

Table 4.2

Correspondence between Grade values and the National System

Performance and defense of laboratory classes		Module test №1	Module test №2	National System
Module № 1	Module № 2			
8	9-10	11-12	13- 14	excellent
6-7	8	9-10	11-12	good
5	6-7	7-8	9-10	satisfactory
under 5	under 6	under7	under 9	failed

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. The Current Module Grade and the Module Test Grade together make up a Total Module Grade whose correspondence to the National System is shown in Table 4.3.

Table 4.3

Correspondence between Total Module Grade Values and the National System

Module № 1	Module № 2	National System
40 - 44	40 - 44	excellent
33 - 39	33 - 39	good
27 – 32	27 – 32	satisfactory
under 27	under 27	failed

4.5. The Total Module Grade received by a student for making and defense of a course project in values, National Scale grades and ECTS Scale grades, is entered into the Module Grade Register.

4.6. The Semester Module Grade is calculated as the sum of the Total Module Grades. The correspondence between Semester Module Grade values and the National System is given in Table 4.4.

Table 4.4

Correspondence between Semester Module Grade Values and the National Scale

Semester Grade Values	National Scale
79-88	excellent
66-78	good
53-65	satisfactory
under 53	failed

Table 4.5

Correspondence between Graded Test Grade Values and the National Scale

Examination Grade Values	National Scale
11-12	excellent
9-10	good
7-8	satisfactory
under 7	failed

4.7. The Semester Module Grade and the Graded Test Grade together make up a Total Semester Grade whose correspondence to the National Scale and the ECTS Scale is shown in Table 4.6.

4.8. The Total Semester Grade is entered into the Examination Register and into a student's record book in values, 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 Discipline Grade corresponds to the Total Semester Grade.

The Total Discipline Grade is entered in the Diploma Supplement

Table 4.6

Correspondence of Total Semester Grades to the National Scale and the ECTS Scale

Total Semester Grade Values	National Scale	ECTS Scale	
		Grade	Explanation
90-100	**Excellent**	**A**	**Excellent** (excellent performance with insignificant shortcomings)
82 – 89	**Good**	**B**	**Very Good** (performance above the average standard with a few mistakes)
75 – 81		**C**	**Good** (good performance altogether with a certain number of significant mistakes)
67 – 74	**Satisfactory**	**D**	**Satisfactory** (performance meets the average standards)
60 – 66		**E**	**Sufficient** (performance meets the minimal criteria)
35 – 59	**Failed**	**FX**	**Failed** (bad performance; a second testing is required)
1 – 34		**F**	**Failed** (very bad performance; a student shall retake the course)

(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				