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MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
National Aviation University  
Educational and Research Airspace Institute  
Engineering Department  
Department of Aviation Machines Manufacturing and Repair Technologies

APPROVED  
Acting Rector

«\_\_\_» \_\_\_\_\_ 2017



## Quality Management System

### SYLLABUS

on

### «Designing of Machines and Mechanisms and Bases of Interchangeability»

Field of study: 13 «Mechanical engineering»  
Speciality: 134 «Aviation and Space Rocket Technology»  
Specialization: Airplanes and helicopters  
Aircraft Equipment

Year of Study – 2 <sup>nd</sup>		Semester – 4 <sup>th</sup>
Classroom Sessions	– 85	Examination – 4 <sup>th</sup> semester
Self-study	– 125	
Total (hours/ECTS credits)	– 210/7	

Course Project – 4<sup>th</sup> semester

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Quality Management System  
Syllabus on  
"Designing of Machines and Mechanisms and  
Bases of Interchangeability"

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The Syllabus on "Designing of Machines and Mechanisms and Bases of Interchangeability" is based on the educational and professional program and Bachelor Curriculum № CB-1-134/16 for Speciality 134 «Aviation and Space Rocket Technology» and Specializations «Airplanes and helicopters», «Aircraft Equipment» and correspondent normative documents.

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## 1. EXPLANATORY NOTE

The Syllabus of discipline "Designing of Machines and Mechanisms and Bases of Interchangeability" is developed on the basis of "The guidelines for the development and execution of training programs and work training courses", enacted by order 16.06.2015r. №37/поз.

The discipline "Designing of Machines and Mechanisms and Bases of Interchangeability" is the last general engineering discipline which combines engineering strength calculations theory and method of machines elements and units and provides fundamental engineering training of engineers.

The purpose of teaching the discipline is formation of students' knowledge about the basics of calculation and designing of typical general purpose machine elements and units and aircrafts and also main principals of interchangeability of details and assembly units in avia and rocket designing.

The main objective of the discipline is:

- to study the general principles of design and construction of elements and components of general and special purpose, which are found in a variety of mechanisms and machines;
- building models and computational algorithms of typical mechanical engineering with regard to the main criteria of efficiency that are needed in creating a new or upgrading existing and reliable operation of the industry equipment;
- studying methods of interchangeability of parts and assembly units at the designing, manufacturing and during their operation;
- ensuring the interchangeability with using "Unified system of tolerances and landings" in engineering

As a result of studying the discipline a student shall:

KNOW:

- main types of modern mechanical transmissions, their structure and design
- principles of designing of mechanisms and machines and features of their functioning;
- method of material selection and determination of allowable stresses;
- method of strength calculation of aircrafts and mechanical transmission typical elements;
- method of calculation and design of mechanical engineering and aircraft mechanisms typical elements which carry and transmit rotatory motion;
- method of strength calculation of mechanical engineering and aircraft elements detachable and permanent joints;
- method of strength calculation of aviation mechanisms
- methodology of details interchangeability at designing, production and operation.

ABLE:

- to carry out engineering design strength calculation of typical machine elements and units;
- to develop a rational mechanism diagram;
- to solve certain design and construction tasks of elements and units on the base of given conditions of operation;
- to form a technical specification for general purpose elements and mechanisms design;
- to carry out the design documentation development stages and content of the individual design stages.

The subject matter of discipline is structured with module principle and is divided into three modules. The separate fourth module is a course project which is carried out in a fourth semester.

Training **module №1 „Bases of Interchangeability”**, training **module № 2 „ Mechanical transmissions”**, training **module № 3 „Machine elements for carrying and transmitting rotatory power and Joints”**, training **module № 4 „Course project”**, 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 and course project defense.

Academic discipline «Designing of Machines and Mechanisms and Bases of Interchangeability» is based on the knowledge got during studying the disciplines: «Higher Mathematics», «Physics», «Descriptive Geometry», «Theoretical Mechanics», «Theory of Mechanisms and Machinery» and is the basis for the study of such disciplines as: «Aviation Materials Science», «Thermodynamics and Heat Transfer», «Aero-Hydro-Dynamics», «Design and strength of aircraft», «Fundamentals of Aviation Products Technology»

## 2. SUBJECT CONTENT

### 2.1. Module number 1 "Fundamentals of interchangeability";

**Topic: 2.1.1 The physical nature of interchangeability and its importance in the development of engineering.** Definition of interchangeability. Interchangeability direction as providing machines and mechanisms in their manufacture.

**Topic: 2.1.2 Classification of interchangeability.** Full and partial interchangeability. **External and internal interchangeability.** Functional interchangeability in machine design mechanisms.

**Topic: 2.1.3. Interchangeability key performance parameters for details.** Interchangeability geometrical parameters for details.

Interchangeability of physical and mechanical parameters details.

**Topic: 2.1.4. Means of measurement in the interchangeability of parts.**

Classification of means of measurement and their purpose. Special equipment to determine the operating parameters of parts in interchangeability.

### 2.2. Module № 2 «Mechanical transmissions».

**Topic 2.2.1. Basic concepts and definitions of basis for machinery calculation and design.**

The main directions of modern mechanical engineering and aircraft. The basic definition. The main criteria for machine performance. Basic requirements for elements and structures material.

**Topic 2.2.2. Fundamentals of designing.**

The design concept. The design tasks. The machine design stages. Types and completeness of design documents. The basic concept of optimal design. The concept of automated design.

**Topic 2.2.3. Mechanical transmissions general information.**

Purpose of transmissions and their classification. The basic kinematic and power ratios of transmissions. Using of mechanical transmissions in aviation technology.

**Topic 2.2.4. Friction transmissions.**

General information, classification, design and principle of operation. Strength calculation of cylindrical friction transmissions. Friction transmissions in engineering.

**Topic 2.2.5. Basic concepts of gearings.**

General Information. Types of gears. Materials of gears and types of heat treatment. Calculated load. Types of teeth failure and gears serviceability criteria. Allowable stresses.

**Topic 2.2.6 Straight spur gears.**

General information. Geometry of straight spur gears. Forces in the engagement of spur gears. Calculations for contact and bending stresses.

**Topic 2.2.7 Helical spur gears.**

General information. Geometry of helical spur gears. Forces in the engagement of helical gears. Equivalent wheel. Calculations for contact and bending stresses. Herringbone spur gears.

**Topic 2.2.8. Bevel gears.**

General information. Geometry of bevel gears. Forces in the engagement of bevel gears. Calculations for contact and bending stresses.

**Topic 2.2.9. Planetary gearings.**



General information, gear ratio, field of use and varieties of planetary gearings. Forces in the engagement. Strength calculations of planetary gearings.

**Topic 2.2.10. Worm gearings.**

General Information. Classification of worm gearings. Geometry of worm gearings. Materials of worm pairs, failure types and allowable stresses. Slippage speed in worm engagement and efficiency. Forces in the engagement. Strength calculation of worm gears. Heat removal analysis of a worm gearing. The use of worm gears in aviation technology.

**Topic 2.2.11. Harmonic gearings.**

General Information. The main structural elements of harmonic drive. Types of wave generators. Materials of transmissions. Harmonic drive gear ratio. Calculation of the harmonic drive. The use of harmonic drive in engineering.

**Topic 2.2.12. Belt drives.**

General Information. Geometrical ratios and forces in transmission. Tension in belt drive. Slide, gear ratio and transmission efficiency. Pulling ability of belt drive. Durability of the belt. Ways of belt strain. Calculation of V-belt and flat belt drives.

**Topic 2.2.13. Chain drives.**

General Information. Basic geometric parameters and kinematics of transmission. Driving chains and sprockets. Performance criteria and calculation of chain drives.

**Topic 2.2.14. Power screw transmissions.**

General information, design and classification. Field of drive application. Design and calculation of power screw transmissions with rolling and sliding friction. Power screw transmissions in aircrafts and technological equipment.

**2.3. Module № 3. « Machine elements for carrying and transmitting rotatory power and Joints ».**

**Topic 2.3.1. Axles and shafts.**

Purpose and principle of operation. Construction of shafts and axles. Materials for shafts production. Designing and checking calculations of shafts. Designing features of reducers and aviation mechanisms shafts.

**Topic 2.3.2. Rolling contact bearings.**

General Information. Classification, labeling and accuracy classes of rolling bearings. The main types of rolling bearings. Selection of bearings for basic and static load rating. Design features of aviation reducers mounting group with rolling bearings.

**Topic 2.3.3. Sliding contact bearings.**

General Information. Bearing construction and industry use. Materials of bearings. Bearings with boundary and fluid friction. Basis of bearings calculation. The use of bearings in aircraft mechanisms mounting groups.

**Topic 2.3.4. Coupling.**

General information. Unmanaged, managed and self-managed couplings. Couplings additional forces on structure elements. Selection of couplings. Checking calculations of coupling elements.

**Topic 2.3.5. Threaded joints.**

General Information. Geometrical parameters of thread. The main types of threads and their standardization. Power relations in threaded joints. Elements of power screw theory. Conditions of self-locking, efficiency of screw pair. Main fasteners. Calculations of threaded joints: loaded by an axial force only; loaded by axial force and torque; loaded by shearing force in the plane of the junction. Calculation of group of bolted joints. Design of threaded joints in aviation mechanisms. Strength classes and materials of threaded elements.

**Topic 2.3.6. Keyed and splined joints.**



General Information. The main types of keyed joints. Choosing of keys and check analysis of keyed joints.

Splined joints. Purpose, classification, application. Check analysis of splined joints. Using of splined joints in aircraft assemblies.

#### **Topic 2.3.7. Riveted joints.**

General Information. Types of rivets and seams. Materials of rivets. Calculation of riveted joints. Operational features of riveted joints in aircraft structures.

#### **Topic 2.3.8. Welded joints.**

General information and industry use. The types of welds. Calculation of welds loaded by force and moment. Design of welded joints in engineering and aircraft structures.

### **2.4. Module № 4 «Course project».**

Course project in the discipline is performed in the fourth semester, in order to consolidate and deepen the theoretical knowledge and skills on the basis of calculation and design of aviation mechanisms mechanical transmissions and drives.

Course project performing is an important stage for the diploma project prospective specialists in designing aircraft preparations.

## **3. LIST OF REFERENCES**

### **3.1. Basic recommended sources**

3.1.1. *Кирилюк Ю.С., Якимчук Г.К., Бугай Ю.М.* Взаємозамінність, стандартизація та технічні вимірювання. – К: КМУЦА. 1997.

3.1.2. *Кудрін А.П., Кулик М.С., Зайвенко Г.М., Волянська Л.Г., Панін В.В.* Технологія літакобудування. Ч. I. Типові технологічні процеси виготовлення деталей літальних апаратів. – К: «НАУ - друк». Підручник. 2009. 265 с.

3.1.3. *Кудрін А.П., Лубяний В.В., Хишко В.Д.* «Взаємозамінність та технічні вимірювання». – К.: Астра-Пол, 2005.

3.1.4. *Грищенко В.Д., Кудрін А.П., Мамлюк О.В., Зайвенко Г.М., Піштя О.І.* Системи автоматизованого проектування в літакобудуванні. Навчальний посібник. – К.: НАУ. 2016. – 122с.

3.1.5. *Павлице В.Т.* Основи конструювання та розрахунок деталей машин. К.: Вища шк., 1993. – 556 с.

3.1.6. *Павлов В.М., Крижановський А.С., Борозенець Г.М.* та ін. Деталі машин. Конспект лекцій. – К.: НАУ, 2008. – 164 с.

3.1.7. *Борозенець Г.М., Павлов В.М., Голубничій О.В.* та ін. Прикладна механіка та основи конструювання: навч. посіб. К.: НАУ, 2015. – 356 с.

3.1.8. *Павлов В.М., Борозенець Г.М., Семак І.В.* Конструювання машин та механізмів: методичні рекомендації і завдання до курсового проекту – К.: НАУ, 2015. – 96 с.

3.1.9. *Киркач Н.Ф., Баласанян Р.А.* Расчет и проектирование деталей машин. Часть II. – Харьков, «Выща школа», 1988. – 142 с.

3.1.10. *Kryzhanovskyi A.S., Kornienko A.O., Bashta O.V.* Machine elements. Course project design: manual. – К.: НАУ, 2015. – 124 p.

### **3.2. Additional recommended sources.**

3.2.1. *Кудрін А.П., Зайвенко Г.М., Волосович Г.А., Хишко В.Д.* Ремонт повітряних суден і авіадвигунів. Підручник. 2003. – К: НАУ 2002.

3.2.2 *Чернілевський В.Д., Павленко В.С., Любін М.В.* Технічна механіка. Кн. 4. Деталі машин, К.: НМК ВО, 1992. – 360 с.

3.2.3. *Цехнович Л.И., Петриченко И.П.* Атлас конструкции редукторов.- К.: „Вища школа”, 1990. – 151 с.

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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 ознайомлення	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				