(Ф 03.02 – 91)

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
National Aviation University
Educational and Research Airspace Institute
Engineering Department

APPROVED
Acting Rector
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«___»_____2017

Quality Management System

SYLLABUS
on
«Theory of Machines and Mechanisms»

Field of study: 27 “Transport Services”
Speciality: 272 “Aviation Transport”
Specializations: Maintenance and Repair of Aircraft and Aircraft Engines
Airports Technologies of Works and Technological Equipment

Year of Study – 2nd — Semester – 4th
Classroom Sessions – 64 — Examination – 4th semester
Self-study – 101
Total (hours/ECTS credits) – 165/5,5
Term Paper – 4th semester

Index CB-1-272/16-2.12

The Syllabus on "Theory of Machines and Mechanisms" is based on the educational and professional program and Bachelor Curriculum № СВ-1-272/16 for Speciality 272 «Aviation Transport» and Specializations «Maintenance and Repair of Aircraft and Aircraft Engines», «Airports Technologies of Works and Technological Equipment» and correspondent normative documents.

Developed by:
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Discussed and approved by the Engineering Department, Minutes №9 of 31.09.2017.
Head of the Department _____M.Kindrachuk

Discussed and approved by the Graduate Department for Speciality 272 «Aviation Transport» and Specialization «Airports Technologies of Works and Technological Equipment» – the Airport Technologies Department, Minutes № _____ of _____2017.
Head of the Department _____ O. Tamargazin

Discussed and approved by the Graduate Department for Speciality 272 «Aviation Transport » and Specialization «Maintenance and Repair of Aircraft and Aircraft Engines» – the Aircraft Airworthiness Retaining Department, Minutes № _____ of _____2017.
Head of the Department _____ S. Dmytriev

Discussed and approved by the Scientific-Methodological-Editorial Board of Educational and Research Airspace Institute, Minutes №_____ of _____2017.
Head of the SMEB _____V.Kravtsov

“Agreed”
Acting Director of the Educational and Research Airspace Institute
_____ S. Dmytriev
“____” _____2017

Director of the Center of Advanced Technologies
_____ V. Kazak
“____” _____2017

Document level – 3b
The planned term between the revisions – 1 year
Master copy

1. EXPLANATORY NOTE

The Syllabus of discipline "Theory of Machines and Mechanisms" 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/роз.

This discipline is the theoretical basis of combined knowledge and skills that form the profile of aviation specialist in fields of kinematics and dynamics of mechanisms and machines, the foundations of mechanism design scheme for a given kinematic and dynamic parameters.

The purpose of teaching the discipline is to form future professionals knowledge on the structure, kinematics and dynamics of modern machines and mechanisms, as well as methods for their design. Acquired knowledge is the basis for the study of modern aeronautical engineering at special departments and need professionals who work in the fields of aircraft and helicopters.

The tasks of the discipline are studying general principles of analysis and synthesis of leverages, cam mechanisms and gear trains, acquisition of practical skills of mechanism structure determination, carrying out kinematic and force analysis of mechanisms, acquaintance with the method of law of motion determination and methods of balancing and motion control of mechanisms and machines.

As a result of studying the discipline a student shall

KNOW:

- principles of designing of mechanisms and machines;
- methods of kinematic analysis of different types of mechanisms;
- designing features of leverage, gear trains and cam mechanisms;
- methods of determination the law of motion of mechanisms under action of applied forces;
- method of balancing and motion control of mechanisms and machines .

ABLE*:*

- to divide mechanisms into separate simpler kinematic chains (groups of links)
- to carry out kinematic analysis of leverage, gear trains and cam mechanisms;
- to determine forces acting on the links of mechanisms and machines as well as reacting forces in movable connections of mechanism links;
- to reduce masses, forces of inertia and moments of a couple of inertia forces to reduced link of a mechanism;
- to solve tasks of designing mechanisms for the given initial data.

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

training **module №1 „Structure, kinematics and dynamics of mechanisms and machines";**

training **module № 2 „Mechanisms with higher pairs"**, 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.

A separate third module is a term paper, which is done by student in the fourth semester. Course paper is an important part to fix and to deepen theoretical and practical knowledge and skills, acquired by student during studying the discipline.

Academic discipline «Theory of Mechanisms and Machines» is based on the knowledge got during studying the disciplines: «Engeneering and Computer graphics», «Physics», «Computer Science», «Higher mathematics», «Theoretical Mechanics», and is the basis for the study of such disciplines as: «Details of Machines», «Design and strength of aircraft», «Technical Operation of Aircraft», «Technical operation of ground aviation technics».

2. SUBJECT CONTENT

2.1. Module №1 "Structure, kinematics and dynamics of mechanisms and machines"

Topic 2.1.1. Main terms and definitions.

Machine-building as the leading branch of the national economy. Theory of mechanisms and machines as a science. Interrelation of TMM with other related disciplines. The role of TMM in the preparation of specialists in aircraft and helicopter engineering.

Definition of mechanism, machine, link, kinematic pair. Classification of kinematic pairs. Degree of freedom of a mechanism.

Topic 2.1.2. Structural analyses of mechanisms.

Structural analyses and synthesis of mechanisms. Groups of links. Group of initial links. Assours groups and their classification. Replacement of higher pairs by lower. Replaced mechanisms. Parasitic links in mechanisms and their exclusion. Determining mechanism structure.

Topic 2.1.3. Kinematic analysis of mechanisms.

Main tasks and methods of kinematic analysis. Construction mechanism plans and paths of individual points. Scale. Standardization of the scale. Vector equation for the velocity and acceleration. Velocity and acceleration diagrams. Theorem for sequences of velocities and accelerations.

Topic 2.1.4. Kinetostatics of mechanisms.

Kinetostatic method of mechanisms force analysis. Main tasks. Classification of acting forces. The forces of inertia. The order of the force analysis of the Assours groups. Determination of balancing moment which is applied at the initial link. Method of Zhukovsky's rigid lever.

Topic 2.1.5. Balancing of rotating links.

The tasks of mechanisms balancing. The static, dynamic and total balancing of rotating links. Determination of balances magnitude and position by graphical and analytical methods. Balancing of aircraft mechanisms.

Topic 2.1.6. The motion of mechanism.

Reducing forces and masses to the reduced link. Dynamic model of mechanisms. Reduced force. Reduced moment

2.2. Module №2. "Mechanisms with higher pairs"

Topic 2.2.1. Gear trains. The parameters of involute spur gear.

Gear trains. Velocity ratio. Involute and its properties. The main parameters of normal gears. Standardization of basic concepts, definitions, parameters of gears. Module. Pitch. Types of circles.

Topic 2.2.2. Modified gearing.

Methods of production of gears. Modified gearing. Offset factor. Interference and undercutting of gears. The phenomenon of wedge gear.

Topic 2.2.3. Determination of the velocity ratio of gear trains. **Theory of gearing.**

Determination of the velocity ratio of gear trains. Multistage gearings and gearings with intermediate gears. Mechanisms with movable axes of gears. The types of planetary gearings. The method of reversal of motion. Use in aviation engines gearboxes. Theory of gearing

Topic 2.2.4. Analysis and synthesis of planetary gearings.

Analytical and graphical methods for kinematic analysis. Differential gear train. Closed differential transmission. Conditions for selection of numbers of teeth of planetary gears. Selection of numbers of teeth.

Topic 2.2.5. Mechanisms of intermittent action.

The main types of mechanisms of intermittent action. Analysis and synthesis of Maltese, ratchet and other mechanisms with given duration of stopping.

Topic 2.2.6. Cam mechanisms. Plotting the graphs of the follower paths.

Cam mechanisms. Plotting the graphs of the follower paths. Types of plane cam mechanisms. Method of reversed motion.

Topic 2.2.7. Profiling plane cam mechanisms.

Plotting the cam profile for different types of cam mechanisms. Designing cam mechanisms taking into account pressure angle. Laws of motion of the follower

Topic 2.2.8. Friction in kinematic pairs. The efficiency.

Types of friction. Sliding friction. The coefficient of sliding friction. Friction in Translational kinematic pair. Friction on an inclined plane. Conditions self-braking. Friction in rotational kinematic pair. Rolling friction. The efficiency as the main characteristic of the machine. Efficiency sequential and parallel connection mechanisms

2.3. Module №3 «Term Paper».

The term paper of discipline is performed in the fourth semester, according to the established approved methodical recommendations, in order to consolidate and extend the knowledge and skills acquired by students in the process of learning the discipline about kinematics and dynamics of mechanisms and machines, bases of mechanism diagram design according to given kinematic and dynamic parameters.

The aim of the course work is to consolidate the knowledge obtained by students in the study subjects and practical skills of research and design mechanisms of modern aircraft. The course work is a major, the most important type of independent work.

For successful implementation of the course the student should **know** the methods for determining the forces and moments of inertia, basic parameters of gears, parameters of involute gearing, conditions of assembly of planetary gearing, to **be able** to draw velocity and acceleration diagrams, to determine the magnitude and direction of the linear and angular velocities and accelerations of mechanism links, to build gear meshing according to calculated data, to draf force diagrams and to determine forces in kinematic pairs, to determine balancing force and balancing moment.

Performance, design and defense of the term paper are carried out by a student individually according to the methodological guides

The elapsed time for doing term paper – up to 30 hours of student's individual work.

3. LIST OF REFERENCES

3.1 Basic recommended sources

3.1.1. Артоболевський И.И. Теория механизмов и машин. – М.: Наука. 1988. – 640 с.

3.1.2. Кіницький Я.Т. Теорія механізмів і машин. . – К.: Наукова думка, 2002. –660 с.

3.1.3. Воронкін М.Ф., Цимбалюк А.А. Основи теорії механізмів і машин: Конспект лекцій. – К.: КМУЦА, 2000.-208 с.

3.2. Additional recommended sources

3.2.1. Бабенко Є.М.Теорія механізмів і машин. Розв'язання задач. Навчальний посібник/ Є.М.Бабенко, А.О.Корнієнко, О.В.Башта, А.С.Крижановський. – К.: Видавництво Національного авіаційного університету «НАУ-друк», 2009. – 124 с.

3.2.2. Theory of Mechanisms And Machines. Laboratory manual / A. Kornienko, O. Bashta, O. Tisov. – K.: NAU, 2011. – 32 p.

3.2.3. Theory of mechanisms and machines. Laboratory works / Authors: Voronkin N., Kononykhin Y., Kryzhanovsky A. – K.: NAU, 2003. – 72 p.

3.2.4. Theory of mechanisms and machines: Kinematic and force analyses of leverages Authors: Kryzhanovsky A., Kononykhin Y. – K.: NAU, 2003. – 48 p.

3.2.5. Theory of mechanisms and machines. Gear trains: A method guide / Authors: A. Kryzhanovskyi, E.Babenko, A. Kornienko. – K.: National aviation university publishing house «NAU-druk», 2009. – 44 p.

(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				