(F 03.02 – 110)

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
Faculty of Architecture, Civil Engineering and Design
Computer Technologies of Airport Construction and Reconstruction Department

AGREED
Dean of the Faculty
_____ Viktor KARPOV
«20» 10 2022

APPROVED
Vice Rector for Academics
_____ Anatolii POLUKHIN
«28» 10 2022

Quality Management System

COURSE TRAINING PROGRAM
on
"Structural Mechanics (Special Course)"

Educational-Professional Program: "Industrial and Civil Engineering"
Field of study: 19 "Architecture and Construction"
Specialty: 192 "Building and Civil Engineering"

Form of training	Sem.	Total (hours/ ECTS credits))	Lec.	Prac.	Lab.	Self-study	HW/CGW/ CW	CP/ TP	Form of control
Full-time	5	135/4,5	34	-	34	676	CGW	-	Graded Test 5th semester

Index: ECB-5 - 192 - 1/22 - 2.1.26

The Course Training Program on "Structural Mechanics (Special Course)" is developed on the basis of the Educational-Professional Program "Industrial and Civil Engineering", Bachelor Curriculum and Extended Curriculum №СВ-5-192-1/21, and № ЕСВ-5-192-1/21, for training higher education seekers of the Bachelor degree of specialty 192 "Building and Civil Engineering" and corresponding normative documents.

Developed by:

Senior Lecturer at the Department of Computer technologies of construction and reconstruction of airports _____ Ihor MASHKOV

Associate professor of the Computer Technologies of Airport Construction and Reconstruction Department _____ Oleksandr HORB

Discussed and approved by the Graduate Department for the Specialty 192 "Building and Civil Engineering" (Educational Professional Program "Industrial and Civil Engineering") – Computer Technologies of Airport Construction and Reconstruction Department, Minutes №2 of October, 25, 2022.

Head of the Department _____ Oleksandr LAPENKO

Guarantor of the Educational and Professional Program _____ Nataliia KOSTYRA

Vice Rector on International Collaboration and Education

_____ Iryna ZARUBINSKA

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INTRODUCTION

The Course Training Program of the academic discipline “Structural Mechanics (Special Course)” was developed on the basis of the "Methodological recommendations for the development and execution of the syllabus of educational discipline of full-time and part-time forms of training", approved by rector’s order No. 249/roz. of 29.04.2021 and relevant regulatory documents.

1. EXPLANATORY NOTE

1.1. Role, goal and objectives of the academic discipline

Academic discipline "Construction Mechanics (special course)" occupies a leading place in the process of professional training for the qualified performance of professional duties of specialists, is the theoretical and practical basis of the body of knowledge and skills that form the profile of a specialist in the field of construction and civil engineering. Studying the course of this discipline is aimed at gaining knowledge of the basics of designing buildings and structures for various purposes.

The goal of teaching the discipline is to reveal the concepts and methods of calculating the structures of buildings and structures of airports, the principles of computer modeling of the main types of structures operating under various mechanical and physical influences, the application of acquired skills in the process of study and future professional activities in the field of construction and civil engineering.

The objectives of the discipline are:

- study and mastery of the basic concepts, theoretical provisions and methods of calculation of strength, stiffness and stability of engineering structures;
- mastery of the basic theoretical principles of construction and analysis of structural systems;
- mastering the basic concepts and methods used in the construction of design schemes of various geometric configurations of structures;
- mastering the methods of calculation of statically determinate and indeterminate rod systems for various types of loads.

1.2. Educational outcomes of the academic discipline

As a result of studying this discipline the student should know:

- principles and methods of calculation for strength and stiffness of structural elements that are part of buildings and structures;
- methods of calculation for stability and the basics of structural dynamics;
- the main directions of development of structural mechanics and automated systems used in engineering practice for optimal design and calculations of strength and stability of structures of construction objects;

- ways to use the results of solving structural mechanics problems to improve the operational and technical characteristics of existing and future facilities.

The program learning outcomes are:

PLO7 – Perform data collection, interpretation and application, including through the search, processing and analysis of information from various sources.

1.3. Competencies obtained through the academic discipline

According to the content of the discipline, the student should be able to:

- practically solve problems in terms of strength, stiffness and stability of typical and individual schemes of engineering building structures;

- as a result of the calculation, evaluate the potential operational capacity of building structure systems and their elements bearing the main load, determine the causes and make informed decisions to eliminate the traces and prevent dangerous destruction;

- correctly apply various methods of structural design depending on the peculiarities of structural mechanics problems that arise during the construction, repair and reconstruction of airport buildings and structures;

- use basic software tools for implementing structural mechanics methods on a PC.

IC. The ability to solve complex specialized tasks and practical problems in the field of construction or in the learning process, which involves the application of theories and methods of determining the strength, stability, durability, reliability and safety of buildings and structures; application of information technologies, software complexes, automated design systems.

General competencies that the discipline enables you to acquire:

GC1 – Ability to think abstractly, analyze and synthesize.GC2 – Knowledge and understanding of the subject area and professional activity. GC6 – Ability to independently acquire knowledge by searching, processing and analyzing information from various sources. GC7 – Interpersonal skills.

Professional competencies that the discipline enables you to acquire:

PC1 – Ability to use conceptual scientific and practical knowledge of mathematics, chemistry and physics to solve complex practical problems in construction and civil engineering. PC4 – Ability to choose and use appropriate equipment, materials, tools and methods for designing and implementing technological processes of construction production. PC7 – Ability to take responsibility for developing and making decisions in the field of architecture and construction in unpredictable work contexts.

1.4. Interdisciplinary links

The discipline "Construction mechanics (special course)" has an interdisciplinary character and combines courses of professional training disciplines. This discipline is based on the knowledge of such disciplines as "Introduction to Civil Engineering", "Higher Mathematics", "Theoretical Mechanics (Statics)", "Resistance of Materials", "Mechanics of Solid Deformable Body", "Structural Mechanics", and is the basis for the study of further disciplines, namely: "Building structures", "Metal structures", "Bases and foundations".

2. PROGRAM OF THE ACADEMIC DISCIPLINE

2.1. Content of the academic discipline

The educational material of the discipline is structured on a modular basis and consists of **two educational modules**, namely:

- training module №1 " Strength calculations based on a deformed scheme. Stability of structural elements ";
- module 2 " Vibrations of elastic systems with several degrees of freedom of concentrated masses", each of which is a logically complete, relatively independent, integral part of the discipline, the mastery of which involves conducting module control work and analyzing the results of its implementation.

2.2. Module structure and integrated requirements for each module

Module №1 “Strength calculations based on a deformed scheme. Stability of structural elements”

Integrated requirements for module 1: ***to know*** basic concepts, definitions and equations in deformed strength calculations; methods of solving problems; stability of structural elements; calculation of frames for stability by the displacement method; determination of the critical force and the form of loss of stability; calculations of frames for stability and strength by deformed scheme by the finite element method; ***be able*** to use the basic theoretical principles of construction and analysis of rod systems and their design schemes; to know the principles and methods of calculation of strength, stiffness and stability of rod systems under the influence of various types of loads.

Topic 1: Strength calculations based on the deformed scheme. Basic concepts and definitions. Methods of solving problems. Differential equation of equilibrium of a rectilinear rod in longitudinal bending. Study of strength and stability of compressed rods by the method of initial parameters.

Topic 2. Calculation of beams and frames for strength by the displacement method.

Basic dependencies of the displacement method for a rectilinear rod of constant stiffness. Calculation of beams and frames for strength by the

displacement method according to a deformed scheme. Application of the Lira CAD software.

Topic 3. Stability of structural elements.

Basic assumptions in stability calculations. Design schemes of frames for stability. Calculation of frames for stability by the method of displacements. Calculation scheme. The equation of stability.

Topic 4. Determination of the critical force and the form of loss of stability.

Determination of the critical force and the form of loss of stability. Flexibility and longitudinal bending coefficient of compressed rods. The reduced length of a compressed rod.

Topic 5. Finite element analysis of frames.

Calculations of frames for stability and strength according to the deformed scheme by the finite element method using the Lira CAD software

Module №2 "Vibrations of elastic systems with several degrees of freedom of concentrated masses"

Integrated requirements for module 2: ***to know*** concepts and assumptions of the dynamics of rod systems; basic methods for solving problems of structural dynamics; equations of motion for natural and forced vibrations; algorithm for calculating elastic systems for natural and forced vibrations; calculations of vibrations by the finite element method basic; ***be able*** to use the mathematical apparatus for calculating rod systems under natural and forced oscillations; to master the principles and methods of calculating the strength of rod systems under dynamic loads; to correctly apply methods of calculating structures depending on the peculiarities of the formulation of structural mechanics problems.

Topic 1: Fundamentals of structural dynamics.

Basic concepts and assumptions of the dynamics of rod systems. Types and characteristics of oscillations of systems. Types of dynamic loads. Degrees of freedom of oscillating masses. Basic methods for solving problems of structural dynamics.

Topic 2. Equations of motion for natural and forced vibrations.

Differential equations of motion of a system with several degrees of freedom under natural and forced oscillations. Systems of algebraic equations for determining the amplitudes of harmonic vibrations.

Topic 3. Natural vibrations of elastic systems.

Natural vibrations of elastic systems with many degrees of freedom of concentrated masses.

Topic 4: Frequencies and forms of natural vibrations.

Spectrum of frequencies and natural vibrations. Theorem on the orthogonality of natural waveforms.

Topic 5. Forced vibrations of elastic systems.

Forced vibrations of elastic systems with many degrees of freedom of concentrated masses.

Topic 6. Calculations of vibrations by the finite element method.

Calculations of natural and forced vibrations by the finite element method using the Lira CAD software.

2.3. Thematic plan of the academic discipline

№ п/п	Topic	Academic hours							
		Full-time study				Part-time study			
		Total	Lectures	Labs	Self-tudy	Total	Lectures	Labs	Self-tudy
1	2	*3*	*4*	5	6	7	8	9	10
Module №1 “Strength calculations based on a deformed scheme. Stability of structural elements”									
1.1	Strength calculations based on a deformed scheme. Basic concepts and definitions. Methods of solving problems. Differential equation of equilibrium of a rectilinear rod in longitudinal bending. Investigation of strength and stability of compressed rods by the method of initial parameters.	**5 semester**				**5 semester**			
		7	2	2	3	-	-	-	-
1.2	Basic dependences of the displacement method for a straight-line rod of constant stiffness. Calculation of beams and frames for strength by the method of displacements according to a deformed scheme.	**7**	2	2	3	-	-	-	-
1.3	Application of the PC "Lira-CAD".	**6**	2	2	2	-	-	-	-
1.4	Stability of structural elements. Basic assumptions in stability calculations. Design schemes of frames for stability.	**7**	2	2	3	-	-	-	-
1.5	Calculation of frames for stability by the displacement method.	**7**	2	2	3	-	-	-	-
1.6	Calculation by the method of displacements. Calculation scheme. Stability equation.	**7**	2	2	3	-	-	-	-
1.7	Determination of the critical force and the form of loss of stability. Flexibility and longitudinal bending coefficient of compressed rods. The reduced length of a compressed rod.	**7**	2	2	3	-	-	-	-
1.8	Calculations of frames for stability and strength according to a defeasible scheme by the finite element method using the Lira CAD software.	**7**	2	2	3	-	-	-	-
1.9	Calculation and graphic work №. 1	**10**	-	-	10	-	-	-	-

1	2	3	4	5	6	7	8	9	10
1.10	Module control work №1	**2**	-	1	1		-	-	-
	Total for Module 1	**67**	16	17	34				
Module №2 " Vibrations of elastic systems with several degrees of freedom of concentrated masses "									
2.1	Fundamentals of the dynamics of structures.Basic concepts and assumptions of the dynamics of rod systems. Types and characteristics of oscillations of systems. Types of dynamic loads. Degrees of freedom of vibrating masses. Basic methods for solving problems of structural dynamics..	**5 semester**				**6 semester**			
		6	2	2	2	-	-	-	-
2.2	Differential equations of motion of a system with several degrees of freedom under natural and forced vibrations. Systems of algebraic equations for determining the amplitudes of harmonic vibrations.	**6**	2	2	2	-	-	-	-
2.3	Natural oscillations of elastic systems with many degrees of freedom of concentrated masses.	**6**	2	2	2	-	-	-	-
2.4	Spectrum of frequencies and natural vibration forms. Theorem on the orthogonality of natural vibration	**7**	2	2	3	-	-	-	-
2.5	Spectrum of frequencies and natural vibration forms. Theorem on the orthogonality of natural vibration	**6**	2	2	2	-	-	-	-
2.6	Vibrations of complex elastic systems with many degrees of freedom.	**7**	2	2	3		-	-	-
2.7	Forced vibrations of elastic systems with many degrees of freedom of concentrated masses.	**7**	2	2	3				
2.8	Calculations of natural vibrations by the finite element method using the Lira CAD software.	**4**	2	-	2				
2.9	Calculations of forced vibrations using the Lira CAD software.	**7**	2	2	3				
2.10	Calculation and graphic work № 2	**10**	-	-	10				
2.11	Module control work № 2	**2**	-	1	1				
	Total for Module 2	**68**	18	17	33				
	Total for Academic Discipline	***135***	***34***	***34***	***67***				

2.4. Assignments for calculation and graphic works

The calculation and graphic works (CGW) in the discipline are performed in the 5th semester, in accordance with the methodological recommendations approved in the prescribed manner, in order to consolidate and deepen the theoretical knowledge and skills acquired by the student in the process of mastering all the educational material of the discipline. Completion of WGR is an important stage in the training of a future specialist.

The specific goal of the first WGW is to calculate the frame for strength and stability by the method of displacements "manually" and with the help of the Lira CAD software.

The specific goal of the second WGW is to calculate elastic systems with several degrees of freedom for natural and forced oscillations.

The development of the calculation graphic work involves performing an automated calculation, which is drawn up by students in the form of an explanatory note of 10-15 pages.

Completion of the explanatory note is a prerequisite for the student's admission to the defense of calculations and the exam. The execution, registration and defense of WGR is carried out by the student individually in accordance with the methodological recommendations.

The time required to complete each WGR is 10 hours of independent work.

2.5. List of questions for exam and final test

The list of questions and content of tasks for preparation for the final control work are developed by the leading teacher of the department in accordance with the work program, approved at a meeting of the department and communicated to students

3. TRAINING MATERIALS FOR THE DISCIPLINE

3.1. Teaching Methods

The following methods of teaching are used in the study of the discipline: explanatory and illustrative method; method of problem presentation; reproductive method; research method.

These methods are implemented during lectures, laboratory work, demonstrations, independent problem solving, work with educational and regulatory and technical literature. The implementation of these methods is carried out during lectures, laboratory work, demonstrations, independent problem solving, work with educational and normative-technical literature.

3.2. Recommended literature

Basic literature

3.2.1. Барабаш М.С. та ін. Основи комп’ютерного моделювання. Навч.посібник /Барабаш М.С., Кір’язєв П.М., Лапенко О.І., Ромашкіна М.А.- К.: НАУ, 2018. –492 с.

3.2.2. Баженов В.А., Перельмутер А.В., Шишов О.В. Будівельна механіка. Комп'ютерні технології. Підручник/ Под ред.: Баженова В.А.– К.: Каравела,2009. – 696 с.

3.2.3. Верюжский Ю.В., Шимановський О.В., Кравцов А.В. Будівельна механіка. Методичні розробки по розрахунку рамних систем на стійкість. – К.: КМУЦА, 1999. – 78 с.

3.2.4. Баженов В.А. та др. Будівельна механіка. Розрахункові вправи. Задачі. Комп'ютерне тестування. Навч. посібник/ Баженов В.А. **,** Іванченко Г.М., Шишов О.В. – К.:Каравела, 2007. – 367 с.

3.2.5. Саргасян А.Е. Будівельна механіка. Основи теорії з прикладами розрахунків. – К.: КМУЦА, 2020. – 346 с.

Additional literature

3.2.6. Верюжский Ю.В., Шимановський О.В., Машков І.Л. Будівельна механіка. Методичні розробки по розрахунку стержневих конструкцій методом скінченних елементів. – К.: КМУЦА, 1999. – 36 с.

3.2.7. Баженов В. А. Будівельна механіка: Електронний підручник / В. А Баженов, О. В. Шишов. – К., 2018. – 436 с.

3.2.8. Писаренко Г.С. Опір матеріалів : підручник / Г.С. Писаренко, О.Л. Квітка, Е.С. Уманський ; за ред. Г.С. Писаренка. – 3-е вид., допов. і переробл. – К. : Вища шк., 2020. – 655 с.

3.3. Information resources on the Internet

3.3.1. http://iap.nau.edu.ua/index.php/kafedry/komp-yuternikh-tekhnologij-budivnitstva

3.3.2. Сайт Науково-технічної бібліотеки Національного авіаційного університету https://www.lib.nau.edu.ua/main

3.3.3. http://er.nau.edu.ua/handle/NAU/24905

3.3.4. Методичні розробки кафедри (в електронному вигляді).

4. RATING SYSTEM OF KNOWLEDGE AND SKILLS ASSESSMENT

4.1. Evaluation of certain types of work done by students of the points made in accordance with Tables.4.1.

Table 4.1.

Type of educational work	Max number of points		Type of educational work	Max number of points	
	Full-time form of study	Part-time form of study		Full-time form of study	Part-time form of study
5 semester					
Module №1: "Strength calculations based on a deformed scheme. Stability of structural elements"			Module №2 "Oscillations of elastic systems with several degrees of freedom of concentrated masses"		
Type of educational work	points	points	Type of educational work	points	points

Laboratory work 8x1b=8	8	5	Laboratory work 8x1b=8	8	10
Performing control (homework) work № 1	-	25	Performing control (home) work № 2	-	20
Performing calculation and graphic work № 1	16	-	Performing calculation and graphic work № 2		
In order to be admitted to the module test №1, a student must score at least	*8*	–	*To be admitted to the module test №2, a student must score at least*	*8*	–
Performing modular control work №1	16	–	Performing a modular control work №2	16	-
Total for module №1	40	30	**Total for module №2**	40	**30**
Total for modules №1, №2				**80**	**60**
Semester exam				**20**	**40**
Total by discipline					**100**

4.2 The completed types of academic work are credited to the student if he received a positive rating for them.

4.3. The sum of the rating grades received by the student for certain types of completed academic work is the current module rating grade, which is entered in the module control record.

4.4. The final semester rating grade is converted to the national scale and ECTS scale.

4.5 The final semester rating grade in points, according to the national scale and the ECTS scale is entered in the test-examination record, study card and student's record book, for example 92/Excellent/A, 87/Good/B, 79/Good/C, 68/Failing/D, 65/Failing/E, etc.

4.6 The final rating grade in the discipline is equal to the final semester rating grade. The specified final rating grade in the discipline is entered in the Diploma Supplement.

(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				

(F 21.01 – 03)

Syllabus of the academic discipline
«RESISTANCE OF MATERIALS (SPECIAL COURSE) AND BASICS OF THE THEORY OF ELASTICITY AND PLASTICITY»
Educational and professional program:
«Industrial and Civil Engineering»,
Field of study: 19 «Architecture and Construction»
Specialty: 192 «Building and Civil Engineering»

Level of higher education	First (Bachelor)
Discipline status	Academic discipline of the compulsory component CC
Course	3
Semester	5, 6
ECTS credits / hours	4,5 / 135
Language of training	Ukrainian, English
What will be studied (subject of study)	Basic concepts, theoretical provisions and methods of calculation of strength, stiffness and stability of engineering structures, basic theoretical principles of construction and analysis of rod systems, methods of calculation of statically determinate and indeterminate rod systems for various types of loading.
Why is it interesting / necessary to study (goal)	The purpose of teaching the discipline is to reveal the concepts and methods of calculating the structures of buildings and airport facilities, the principles of computer modeling of the main types of structures operating under various mechanical and physical influences, the application of acquired skills in the process of study and future professional activities in the field of construction and civil engineering.
What can you learn (learning outcomes)	As a result of studying this discipline the student should know: principles and methods of calculation for strength and stiffness of structural elements that are part of buildings and structures; methods of calculation for stability and the basics of structural dynamics; the main directions of development of structural mechanics and automated systems used in engineering practice for optimal design and calculations of strength and stability of structures of construction objects; ways to use the results of solving structural mechanics problems to improve the operational and technical characteristics of existing and future facilities. PLO7 – Perform data collection, interpretation and application, including through the search, processing and analysis of information from various sources.
How to use the acquired knowledge and skills (competencies)	GC1 – Ability to think abstractly, analyze and synthesize.GC2 – Knowledge and understanding of the subject area and professional activity. GC6 – Ability to independently acquire knowledge by searching, processing and analyzing in-formation from various sources. GC7 – Interpersonal skills. Professional competencies that the discipline enables you to acquire: PC1 – Ability to use conceptual scientific and practical knowledge of mathematics, chemistry and physics to solve complex practical problems in construction and civil engineering. PC4 – Ability to choose and use appropriate equipment, materials, tools and methods for designing and implementing technological processes of construction production. PC7 – Ability to take responsibility for developing and making decisions in the field of architecture and construction in unpredictable work contexts.

Educational logistics	**Contents:** Strength calculations according to the deformed scheme. Basic concepts and definitions. Methods of solving problems. Differential equation of equilibrium of a straight rod in longitudinal bending. Investigation of strength and stability of compressed rods by the method of initial parameters. Basic dependences of the displacement method for a rectilinear rod of constant stiffness. Calculation of beams and frames for strength by the displacement method according to a deformed scheme. Application of the software "Lira-CAD". Stability of structural elements. Basic assumptions in stability calculations. Design schemes of frames for stability. Calculation of frames for stability by the method of displacements. Calculation scheme. Stability equation. Determination of the critical force and the form of loss of stability. Flexibility and longitudinal bending coefficient of compressed rods. The reduced length of the compressed rod. Calculation of frames for stability and strength according to the deformed scheme by the finite element method using the Lira CAD software. Fundamentals of structural dynamics. Basic concepts and assumptions of the dynamics of rod systems. Types and characteristics of oscillations of systems. Types of dynamic loads. Degrees of freedom of oscillating masses. Basic methods for solving problems of structural dynamics. Differential equations of motion of a system with several degrees of freedom under natural and forced oscillations. Systems of algebraic equations for determining the amplitudes of harmonic vibrations. Natural vibrations of elastic systems with many degrees of freedom of concentrated masses. Solving problems of oscillations of elastic systems with many degrees of freedom. Spectrum of frequencies and forms of natural oscillations. Theorem on the orthogonality of natural oscillation forms. Oscillations of complex elastic systems with many degrees of freedom. Forced vibrations of elastic systems with many degrees of freedom of concentrated masses. Calculations of natural oscillations by the finite element method using the Lira CAD software. Calculations of forced oscillations using the Lira-SAPR software. **Classroom sessions:** lectures, laboratory classes. **Teaching methods:** explanatory and illustrative method, method of problem presentation, reproductive and research methods. **Form of training:** full-part
Prerequisites	"Introduction to Civil Engineering", "Higher Mathematics", "Theoretical Mechanics (Statics)", "Resistance of Materials", "Mechanics of Solid Deformable Body", "Construction Mechanics"
Porekvizyty	"Building structures", "Metal structures", "Bases and foundations"

Information support from the repository and fund of NTB NAU	Барабаш М.С. та ін. Основи комп'ютерного моделювання. Навч.посібник /Барабаш М.С., Кір'язєв П.М., Лапенко О.І., Ромашкіна М.А.- К.: НАУ, 2018. –492 с. Баженов В.А., Перельмутер А.В., Шишов О.В. Будівельна механіка. Комп'ютерні технології. Підручник/ Под ред.: Баженова В.А.– К.: Каравела,2009. – 696 с. Верюжский Ю.В., Шимановський О.В., Кравцов А.В. Будівельна механіка. Методичні розробки по розрахунку рамних систем на стійкість. – К.: КМУЦА, 1999. – 78 с. Баженов В.А. та др. Будівельна механіка. Розрахункові вправи. Задачі. Комп'ютерне тестування. Навч. посібник/ Баженов В.А. , Іванченко Г.М., Шишов О.В. – К.:Каравела, 2007. – 367 с. Саргасян А.Е. Будівельна механіка. Основи теорії з прикладами розрахунків. – К.: КМУЦА, 2020. – 346 с. Верюжский Ю.В., Шимановський О.В., Машков І.Л. Будівельна механіка. Методичні розробки по розрахунку стержневих конструкцій методом скінченних елементів. – К.: КМУЦА, 1999. – 36 с. Баженов В. А. Будівельна механіка: Електронний підручник / В. А Баженов, О. В. Шишов. – К., 2018. – 436 с. Писаренко Г.С. Опір матеріалів : підручник / Г.С. Писаренко, О.Л. Квітка, Е.С. Уманський ; за ред. Г.С. Писаренка. – 3-е вид., допов. і переробл. – К. : Вища шк., 2020. – 655 с.
Location and logistics	http://www.lib.nau.edu.ua
Semester control, examination methods	Module tests, written exam
Depertment	Construction Computer Technologies and Airports Reconstruction
Faculty	Archictecture, civil engineering and design
Professor	 **HORB OLEKSANDR** **Position:** Associate Professor **Scientific degree:** Candidate of Sciences **Academic title:** - **Profile:** http://iap.nau.edu.ua/images/LAP_ACRED/npp2/Gorb.pdf **tel.: 044-406-74-25** **E-mail:** oleksandr.horb@npp.nau.edu.ua **Room:** 5.510
Originality of academic discipline	Original
Link to discipline	https://er.nau.edu.ua/handle/NAU/24905