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 of Architecture,
Civil Engineering and Design
_____ V. Karpov
"30" 09 2022

APPROVED
Vice Rector for Academics
_____ A. Polukhin
"05" 10 2022

Quality Management System

COURSE TRAINING PROGRAM
on
«Metals and Welding in Construction»

Educational-Professional Programs: "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	Home-work control work	CP/ TP	Form of control
Full-time	7	120,0/4,0	17	–	34	69	-	-	Graded Test, 7th semester
Part-time									

Index: СВ - 5 - 192 - 1 / 21-3.12

The Course Training Program on "Constructions of Buildings and Structures" is developed on the basis of the Educational-Professional Programs "Industrial and Civil Engineering", "Highways and Airfields", Bachelor Curriculum and Extended Curriculum № CB-5-192-1/21, № ECB-5-192-1/21 for training higher education seekers of the Bachelor degree of specialty 192 "Building and Civil Engineering" and corresponding normative documents.

Associate professor of
Computer Technologies of
Construction and Airport Reconstruction
Department _____ Nataliia Kostyra

Discussed and approved by the by the Graduate Department for the Specialty 192 "Building and Civil Engineering" (Educational-Professional Programs "Industrial and Civil Engineering" and "Highways and airfields") – the Computer Technologies of Construction and Airport Reconstruction Department,
minutes № 10 of "29" 09 2022.

Guarantor of the Educational- Professional Program
"Industrial and Civil Engineering" _____ Nataliia Kostyra

Head of the Department _____ Oleksandr Lapenko

Vice Rector on International Collaboration and Education

_____ I. Zarubinska

"03" 10 2022

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INTRODUCTION

The Course Training Program of the academic discipline "Metals and Welding in Construction" 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

The discipline has an independent meaning and is one of the main disciplines forming a specialist in the field of industrial construction. On the basis of the knowledge and skills acquired by students while studying the discipline, the future specialist, in the case of working in design organizations, will design part of the projects related to the design of load-bearing metal structures of industrial buildings.

The **goal** of teaching the discipline is to provide the future specialist with knowledge in the field of calculation and construction of welded metal structures of industrial buildings, taking into account the requirements of the manufacturability of the production of structural elements, their transportation, installation and technical operation.

The objectives of the educational discipline is to improve the student's knowledge in the field of choosing the optimal structural building materials, the choice of rational structural systems of the construction objects being designed; acquiring skills in designing and calculating the load-bearing structures of the frame of a one-story industrial building; the student's acquisition of knowledge of the rules for designing metal structures in accordance with current standards; mastering the rules of construction and calculation of the nodes of the connection of structures in the building, taking into account the conditions of production, installation and technical operation of industrial buildings.

1.2. Educational outcomes of the academic discipline

As a result of studying the discipline, the specialist should know calculation methods and rules for designing the load-bearing structures of one-story industrial buildings, taking into account the peculiarities of the physical and mechanical properties of steels; algorithms for calculating structures with welded joints; technological possibilities of factory production of steel structures, rules of transportation, installation and technical operation of building structures. PLO9 – Design building structures, buildings, structures and engineering networks, taking into account engineering and resource-saving measures, legal, social, environmental, technical and economic indicators, scientific and ethical aspects, and modern requirements of regulatory documentation in the field of architecture and construction, environmental protection and labor safety. PLO14 – Ensure reliable and safe operation of building constructions, structures and engineering networks.

1.3. Competencies obtained through the academic discipline

As a result of studying the discipline, the higher education seeker should be able to determine the dimensions of the industrial building transverse frame, determine the loads that act on structural elements of the frame, determine the efforts in the elements of the frame and carry out computer calculations of metal structures, as well as the entire structure as a whole, design the load-bearing elements of buildings and structures and nodes of their connections, as well as evaluate the technical and economic efficiency of the adopted constructive decision.

General competences: 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.

Professional competences: PC3 – Ability to design building structures, buildings, structures and engineering networks (according to specialization), taking into account engineering and resource-

saving measures, legal, social, environmental, technical and economic indicators, scientific and ethical aspects, and modern requirements of regulatory documentation in the field of architecture and construction, environmental protection and labor safety. PC6 – Ability to perform engineering activities in the field of construction, compilation and use of technical documentation.

1.4. Interdisciplinary links

This discipline is based on the knowledge of such disciplines as "Structural Mechanics", "Architecture of Buildings and Structures", "Metal Structures" and is the basis for studying further disciplines, namely: "Construction Economics", "Organization of Construction", "Foundation Engineering", and also performance of Qualification Paper.

PROGRAM OF THE ACADEMIC DISCIPLINE

2.1. Content of the academic discipline

The educational material of the discipline is structured according to the modular basis and consists of two educational modules, namely:

- **educational module 1 "Constructive forms of metal structures";**

- **educational module 2 "Metal frameworks of single-story industrial buildings",** each of which is a logically completed, relatively independent, integral part of the educational discipline, mastering which involves a modular test and results analysis.

2.2. Module structure and integrated requirements for each module

Module №1 "Constructive forms of metal structures"
Integrated requirements for module 1: *to know*:

- calculation methods and rules for designing load-bearing structures of buildings and structures, taking into account the peculiarities of the physical and mechanical properties of steels and aluminum alloys, their chemical composition;
- algorithms for calculating structures with welded joints;
- technological possibilities of factory production of steel structures, rules of transportation, installation and technical operation of construction structures;

***be able*:**

- independently choose the optimal grades of steel and aluminum alloys for building structures, calculate and assign the parameters of the cross-sections of the load-bearing elements of the structures;
- to assign the type of connections of separate structural elements, to design the nodes of structural connections in the building depending on the specific conditions of their operation;
- carry out an assessment of the technical and economic efficiency of the adopted constructive decision.

Topic 1. Constructive forms. Progressive directions of metal structures development

Formation of structural forms from separate elements - beams, columns, trusses, arches, slabs, membranes, etc. Constructive forms of the building frame, tank, tower, bridge, transverse frame of the skeleton, crane beam, column, truss.

Distribution of constructive forms by type and static work. The main criteria that determine the structural form. Modern ideas of forming a constructive form. Modern structural forms, which include frame and arch frames, vaults, domes and structural roof system.

Topic 2. General characteristics of industrial buildings

An industrial building as a complex of building structures, which takes up static and dynamic loads induced from its own weight, as well as from climatic and technological influences. Features of

the technological process and conditions of its normal functioning. The basis of the frame of the industrial building. Providing the rigidity and stability of the frame in the longitudinal direction by the system of braces in the roof plane and vertical braces between columns.

Topic 3. The main load-bearing elements of the industrial buildings frame

The main load-bearing elements of the frame, which are part of the transverse frame, take up the load and transfer it to the foundation.

Steel columns of constant cross-section by the height or stepped of the building transverse frame. Trusses of industrial buildings with parallel chords, trapezoidal and triangular.

Topic 4. Roof structures of industrial buildings

Roof structures of industrial buildings with or without purlins. A solution with reinforced concrete ribbed slabs, which act as load-bearing elements of space-enclosing structures. Typical trusses with parallel chords. Roof covering from rolled or mastic materials. Design decisions for light roof coverings with purlins.

Module №2 «Metal frameworks of single-story industrial buildings»

Integrated requirements for module 2: *to know*:

- rules for the layout of the building transverse frame;
- rules for determining the load acting on the transverse frame;
- rules for drawing up schemes of structural elements of the transverse frame;

***be able*:**

- determine the dimensions of the building transverse frame;
- independently determine the loads acting on load-bearing elements of the frame;
- independently determine the efforts in the frame load-bearing structural elements;
- independently carry out computer calculations of metal structures, as well as the entire building as a whole, design the load-bearing elements of buildings and structures and their connection nodes, optimize structural solutions in their proposals.

Topic 1. Types of single-story industrial buildings frames

The basis of the frames of industrial single-story buildings is made of plane transverse frames, which are formed by columns and girders. Transverse frames that ensure geometric stability and stiffness of the skeleton in the transverse direction. Classification of frames depending on the presence and type of crane equipment and depending on the number of columns in the transverse direction.

Topic 2. Layout of the transverse frame of the workshop

Determination of vertical dimensions, based on the dimensions of the crane equipment and the given height of the building. Determining overall dimensions of crane equipment. Determination of the length of the upper over-crane part and the length of the lower (under-crane) part of the column.

Determination of horizontal dimensions, which depends on the columns snapping to the longitudinal axes, as well as on the mode of operation of the crane equipment.

Topic 3. Braces of the building framework. Calculation of building frame vertical and lateral braces

Braces functions that work in conjunction with structural elements of the framework. Schemes of the braces' arrangement in the bottom and top chords of the trusses. Vertical braces between the columns of the framework.

Selection of cross-sections of braces elements according to ultimate flexibility (according to SBN B.2.6-198-2014).

Selection of X-shaped braces cross-sections cross as tensioned elements. Checking the flexibility of tensioned elements only in the vertical plane and the absence of dynamic loads.

Selection of braces cross-sections (with the exception of cross tie braces) as compressed elements. Determination of the rating length of brace elements based on the assumption of the presence of hinges in all nodes.

Topic 4. Mechanical loads applied on transverse frame of a single-story industrial building

Determination of the load from the dead weight of the roof and roof covering structures per $1m^2$; linear evenly distributed load on the frame roof girder from the self-weight of the roof covering; bearing reaction of the frame girder; dead weight of the column; rating total load on the over-crane and under-crane parts of the column from the own weight of the column and the wall panels, taking into account the coefficient reliability on the purpose.

Topic 5. Snow load applied on transverse frame

Determination of the limit rating snow load per 1 sq. meter of the area of the roof covering horizontal projection in accordance with the design standards.

Static calculation according to rating schemes with a conditional solid girder loaded from snow, as well as from its own weight, is assumed to be evenly distributed along the length of the span.

Topic 6. Loads from overhead travelling cranes

Determination of the load from overhead travelling cranes, which is transmitted directly to the rails in the places of contact with the running wheels and is vertical and horizontal in its direction.

Topic 7. Wind load applied on transverse frame

Determination of the limit rating value of the static component of wind active and back pressure applied perpendicular to the exterior surface of the building or its element.

Taking into account the wind load acting above the bottom chord of the roof truss, according to the calculation scheme as concentrated force.

Topic 8. Static calculation of transverse frames

Determination of forces in elements of a frame by static calculation for each load separately.

Replacement when calculating frames using simplified calculation schemes of a open-web roof truss with a solid one equivalent to it in terms of stiffness.

Application of construction mechanics methods (the method of displacements) in manual calculations. Design of diagrams to determine the bearing reactions of columns of solid and stepped cross-sections.

Topic 9. Determination rating combinations of loads acting in cross-sections of an open-web column

Determination of rating efforts in the elements of the transverse frame of the industrial building skeleton. Rating combinations of bending moments, longitudinal and transverse forces, which assume in according to the requirements for the main combinations of loads. The first group of basic combinations of loads, which includes a constant and one short-term load. Inclusion in the calculation of two or more short-term loads according to the second group of rating combinations.

Main cross-sections for columns, in which rating combinations of efforts should be compose.

Topic 10. Calculation and design of an open-web column of a single-story industrial building frame

Designing the shaft of an open-web columns of industrial buildings from two pieces connected by a triangular lattice of single angles.

Checking the bearing capacity - the stability of a separate piece as a central compressed element and the stability of a column as a single open-web eccentrically compressed element.

Checking the pieces of open-web columns for stability both in the plane of the frame, which is parallel to the plane of the connecting lattice, and out of plane.

Topic 11. Calculation and design of a crane beam

The statical work of under-crane structures is in difficult conditions, which are characterized by the presence of a mobile load and the dynamic nature of the application of vertical and horizontal forces from these cranes.

Calculation of crane beams when no more than two overhead travelling cranes are placed on them in an unfavorable position, in which the largest bending moment and transverse force occur.

Checking the normal stresses in the section where the maximum bending moment acts. Checking the tangential stresses in the section where the maximum transverse force acts. Checking local stresses in the compressed zone of the beam web at the place of application of the concentrated pressure of the crane wheel. Checking the combined stresses in the web where normal, tangential and local stresses are acting at the same time. Checking the general stability of the beam and deflections (stiffness).

Topic 12. Calculation and design of a single-story industrial building roof truss

Calculation of the roof truss when it's loaded by constant load (own weight of the load-bearing roof structures and roof covering with insulation) and temporary (from suspended equipment, snow and wind) loads. Determination of the load on the trusses in the form of concentrated forces applied at the nodes.

2.3. Thematic plan

№	Topic	Academic hours							
		Full-time study				Part-time study			
		Total	Lectures	Labs	Self-study	**Total**	Lectures	Labs	Self-study
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Module №1 «Constructive forms of metal structures»									
1.1	Structural forms. Progressive directions of metal structures development. Materials for metal structures. Metals in construction. Assortments.	**7 Semester** 6 4	2 -	2 2	2 2	**7 Semester** -	-	-	-
1.2	General characteristics of industrial buildings. The main fundamentals of the metal structures calculation	6 4	2 -	2 2	2 2	-	-	-	-
1.3	The main load-bearing elements of the industrial building's framework. Calculation of welded joints. Calculation and construction of butt joints. Calculation and construction of fillet welds.	5 4	1 -	2 2	2 2	-	-	-	-
1.4	Roof structures of industrial buildings. Limit states and calculation of centrally compressed elements.	5 3	1 -	2 1	2 2	-	-	-	-
1.5	Module test №1	3	-	1	2	-	-	-	-
	Total for Module №1	**40**	**6**	**16**	**18**				
Module №2 «Metal frameworks of single-story industrial buildings»									
2.1	Types of a single-story industrial buildings' steel frames.	4	1	-	3	-	-	-	-
2.2	The determination of the transverse frame dimensions	4	-	2	2				

1	2	3	4	5	6	7	8	9	10
2.3	Braces of the building framework.	4	1	-	3	-	-	-	-
	Calculation of building frame vertical and lateral braces	4	-	2	2				
2.4	The loading on the transverse frame of a single-story industrial building.	4	1	-	3	-	-	-	-
	Determination of the constant load on the transverse frame of a single-story industrial building.	4	-	2	2				
2.5	Determination of the snow load on the transverse frame of a single-story industrial building	7	1	2	4	-	-	-	-
2.6	Determination of the crane load on the transverse frame of a single-story industrial building	7	1	2	4	-	-	-	-
2.7	Determination of the wind load on the transverse frame of a single-story industrial building	7	1	2	4	-	-	-	-
2.8	Statical calculation of transverse frames	4	1	-	3				
2.9	Determination rating combinations of the efforts, which are acting to cross sections of the column	7	1	2	4				
2.10	Calculation and design of open-web column of the single-story industrial building frame. Calculation and design of the connection of the above-crane and under-crane parts of the column, the base of the column	4 4	1 -	- 2	3 2				
2.11	Calculation and design of crane beams	6	1	-	5				
2.12	Calculation and design of frame girder (truss) of the one-story industrial building	6	1	1	4				
2.13	Module test №2	4	-	1	3	-	-	-	-
Total for Module №2		**80**	**11**	**18**	**51**				
Total for Academic Discipline		**120**	**17**	**34**	**69**				

3. TRAINING MATERIALS FOR THE DISCIPLINE

3.1. Teaching Methods

When studying the discipline, the following teaching methods are used:
- explanatory-illustrative method;
- method of problem statement;
- reproductive method.

The implementation of these methods is carried out during lectures, demonstrations, independent work, work with educational literature, solving problems in civil engineering

3.2. Recommended literature

Basic literature

3.2.1. Барабаш М.С., Козлов С.В., Медведенко Д.В. Комп'ютерні технології проектування металевих конструкцій. – Київ: НАУ, 2012. – 572 с.

3.2.2. Пермяков В.О., Нілов О.О., Шимановський О.В. і др. Металеві конструкції: Підручник / Під загальною редакцією В.О. Пермякова та О.В. Шимановського. – К.: Видавництво «Сталь», 2008. – 812 с.
3.2.3. Metal Structures. Metal and welding in Construction : manual / A.O. Bielyatynskyi, V.N. Pershakov, O. I. Pylypenko and other. – K.: NAU, 2013. – 208 p.
3.2.4. Клименко Ф.Є., Барабаш В.М., СтороженкоЛ.І. Металеві конструкції. –Львів: Світ, 2002. –313с.
3.2.5. ДБН В.2.6-198-2014. Сталеві конструкції Норми проектування. –К.: Мінбуд України, 2014. –190 с.

Additional literature

3.2.6. ДСТУ Б В.1.2.-3:2006. Прогини та переміщення. Вимоги проектування. –К.: Мінбуд України, 2006. –11с.
3.2.7. ДБН В.1.2-2:2006. Навантаження і впливи. Норми проектування. –К.: Мінбуд України, 2006. –60 с.
3.2.8. Горбатов В.С., Першаков В.М., Ткаченко С.І. Метали і зварка в будівництві: Навчальний посібник (англійською мовою). –К.:НАУ, 2005. –184с.
3.2.9. Козлов С.В., Костира Н.О. Метали і зварювання в будівництві. Методичні рекомендації до виконання курсового проекту. – К.: Вид-во Нац. Авіац. ун-ту «НАУ-друк», К.: НАУ, 2010 – 76 с.

3.3. Internet information resources

3.3.1 Кафедра комп'ютерних технологій будівництва та реконструкції аеропортів // Репозиторій Національного авіаційного університету : веб-сайт. URL: https://er.nau.edu.ua/handle/NAU/9121
3.3.2 Науково-технічна бібліотека НАУ // Науково-технічна бібліотека НАУ: веб-сайт. URL: http://www.lib.nau.edu.ua/main/3.3.2. https://www.minregion.gov.ua/about/
3.3.3 Репозиторій Національного Авіаційного Університету // Репозиторій Національного Авіаційного Університету : веб-сайт. URL: https://er.nau.edu.ua/
3.3.4. Державна наукова архітектурно-будівельна бібліотека імені В. Г. Заболотного // Державна наукова архітектурно-будівельна бібліотека імені В. Г. Заболотного : веб-сайт. URL: http://www.dnabb.org/
3.3.5. Національна бібліотека України імені В. І. Вернадського // Національна бібліотека України імені В. І. Вернадського : веб-сайт. URL: http://www.nbuv.gov.ua/
3.3.6 Міністерство розвитку громад та територій України // Офіційний веб-сайт Міністерства https://www.minregion.gov.ua/about/

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 Table. 4.1.

Table 4.1.

Kind of Academic Activities	Maximum Grade		Kind of Academic Activities	Maximum Grade	
	Full-time study	Part-time study		Full-time study	Part-time study
7 Semester					
Module № 1 «Constructive forms of metal structures»			Module № 2 «Metal frameworks of single-story industrial buildings»		
Carrying out and defending the task of the laboratory classes	**20**		Carrying out and defending the task of the laboratory classes	**40**	
			Carrying out the control (home) work		
For carrying out a module test 1 a student must receive not less than	12	–	*For carrying out a module test 2 a student must receive not less than*	24	–.
Carrying out a module test №1	**20**		Carrying out a module test №2	**20**	–
Total for modules №1	**40**	–	**Total for modules №2**	**60**	**-**
Total for modules №1, №2				**100**	**-**
Total for academic discipline				**100**	

A Semester Grade is determined (in points and in the National Scale) as a result of performing all kinds of educational work during the semester.

4.2. A student is considered to have passed the module if both his/her Current Module Grade and Module Test Grade are positive.

4.3. The Semester Module Grade is calculated as the sum of the Total Module Grades.

4.4. The Semester Module Grade and the Graded Test together make up a Total Semester Grade which is calculated according to the National Scale and the ECTS Scale.

4.5. The Total Semester Grade in points, the National Scale and the ECTS Scale is written into a student's record book, for example: ***92/Ex/A, 87/Good/B, 79/Good/C, 68/Sat/D, 65/Sat./E***, etc.

4.6. The Total Semester Grade of the subject is determined as the arithmetic average grade of the total semester grades in points (for the second semester for this subject) with its further transfer into the National Scale and ECTS Scale. The indicated Total Semester Grade of the subject 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				