NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Mechanics

REVIEWED
at the meeting of the Faculty of Design and Engineering

"__10__" ___06_____2025

CURRICULUM OF ACADEMIC DISCIPLINE

0k 15 Mechanics of materials and constructions

Area of knowledge	13 "Mechanical Engineering"
Specialty	133 "Sectoral mechanical engineering"
Academic programme	Building and civil engineering
Faculty	Sectoral mechanical engineering

Developed by: Assoc. Prof. of Department of Mechanics, Ph. D. of Physical and Mathematical Sciences, Assoc. Prof. _____ Anastasiia KUTSENKO

Kyiv – 2025

Description of the discipline **Mechanics of materials and constructions**

(name)

Academic degree, specialty, academic programme		
Academic degree	Bachelor	
Specialty	13 "Mechanical engineering"	
Academic programme	133 "Sectoral mechanical engineering"	
Characteristics of the discipline		
Type	compulsory	
Total number of hours	210	
Number of ECTS credits	7	
Number of modules	5	
Course project (work) (if any)	-	
Form of assessment	*credit / exam*	
Indicators of the discipline for full-time and part-time forms of university study		
	Full-time	Part-time
Year of study	2	2
Semester	*3*	*4*
Lectures	45hours.	*30* hours.
Practical classes and seminars	*15* hours.	*15* hours.
Laboratory classes	*15* hours.	*30* hours -
Self-study	*30* hours.	*30* hours.
Number of hours per week for full-time students	*5 hours*	5 *hours*

1. Aim, objectives, competences and expected learning outcomes of the discipline

Aim is skills of solving problems of Mechanics of materials and structures and laying the basis for the study subjects: "Load-lifting machines", "Building machinery", "Machine elements".

Objectives are the study of the methods of calculation of structures for strength, rigidity and stability; the study of the stress-strain state of the beam at tension and compression, at direct shear, at torsion and at bend.

Acquisition of competences:

Integral competence (IC):

A person's skils to solve complex specialized problems and practical problems in a certain professional field activity or in the learning process that involves application of certain theories and methods of relevant sciences in uncertainty and complex conditions.

General competences (GC):

- GC2 – The ability to apply knowledge in the practical situations.
- GC5 – The skills of generation of new ideas (creativity).
- GC8 – The ability to act socially responsibly and consciously.

GC13 – The ability to reserve and multiply moral, cultural, scientific values and achievements of society on based on the understanding of history and patterns of development subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies, use different types and forms of motor activity for active recreation and leading a healthy lifestyle.

Special (professional) competences (SC):

- SC1 – The ability to use conceptual scientific and practical knowledge in mathematics, chemistry and physics to solve complex practical problems in the branch of construction and civil engineering.
- SC7 – The ability to take responsibility for making and making decisions in the branch of architecture and construction in unpredictable work conditions.

Expected Learning Outcomes (ELO):

- ELO 2 – The participate in research and development in the branch of architecture and construction.
- ELO 7 – The collect, the interpret and an apply data, including through the search, processing and analysis of information from various sources.
- ELO 11 – The avaluation of compliance of projects with design principles urban areas and infrastructure facilities and urban economy.

2. The program and structure of discipline for

- full term daily/distance learning first year students in 3 and 4 semesters 2024/2025 academic year

Title of thematic modules and Topics	Hour numbers												
	Daily learning							Distance learning					
	Weeks	Total	Including					Total	Including				
			l	p	lab	ind	i.s.		l	p	lab	ind	i.s.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
3 semester													
Module 1. **Tension and Compression**													
Topic 1. Purpose and objectives of the course. The basic hypotheses and the definitions of the mechanics of materials and constructions.	1	6	2		2	2							

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Topic 2. The relation among internal forces and tensions in case of tension or compression of the bar.			2										
Topic 3. The method of calculating the bar on strength	2	6	2	2		2							
Topic 4. The method of calculating the bar on rigidity	3	10	2		2	2							
Topic 5. The calculation of bar on strength with in terms of weight and temperature.			2										
Topic 6. The calculation of statically indeterminate bars.	4	6	2	2		2							
Total of module 1		28	12	4	4	8							
Module 2. **Torsion**													
Topic 1. The geometric characterizations of the plane cross sections.	5	8	4		2	2							
Topic 2. The geometric characterizations of the plane cross sections.	6	6	2	2		2							
Topic 3. Analysis of Stress and Strain	7	8	4		2	2							
Topic 4. The direct shear stresses.	8	6	2	2		2							
Topic 5. The definition of torsion.	9	8	2		2	2							
Topic 6. The method of calculating the bar on strength and rigidity by torsion			2										
Total of module 2		36	16	4	6	10							

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Module 3. **Beam bending**													
Topic 1. The equation of Shearing force for the cantilever and simple beams	10	6	2	2		2							
Topic 2. The equation of Bending moment for the cantilever and simple beams.	11	8	2		2	2							
Topic 3. The calculation method cantilever beam on the strength by the normal stresses			2										
Topic 4. The calculation method simple beam on the strength by the normal stresses.	12	6	2	2		2							
Topic 5. The definition of supports reaction of curveted beam	13	9	2		2	2							
Topic 6. The building of diagrams of internal efforts for a curveted beam			3										
Topic 7. Double – integration method	14	6	2	2		2							
Topic 8. Verescagin´s rule.	15	6	2	1	1	2							
Total of module 3		41	17	7	5	12							
Total hour of Semester 3		105	45	15	15	30							
4 semester													
Module 4**. Methods of definition of beam systems deformations**													
Topic 1. Castigliano´s theorem.	1	8	2		2	2							
Topic 2. The More's integral.	2	4	2	2	2	2							

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Topic 3. The construction method of the diagram of shear-force and bending-moment for the cantilever frame	3	8	2		2	2							
Topic 4. The construction method of the diagram of shear-force and bending-moment for the simple frame.	4	6	2	2	2	2							
Topic 5. The definitions of the statically indeterminate constructions.	5	8	2		2	2							
Topic 6. The application of the Castigliano´s theorem to the statically indeterminate constructions.	6	6	2	2	2	2							
Topic 7. The three moment's theorem.	7	6	2		2	2							
Topic 8. The application of the Verescagin´s rule to the statically indeterminate constructions.	8	6	2	2	2	2							
Total of module 4		52	16	8	16	16							
Module 5**. Complex stresses**													
Topic 1. Analysis of Stress and Strain in the case of combined bending and tension or compression	9	8	2		2	2							
Topic 2. Analysis of Stress and Strain in the case of a complex bending	10	6	2	2	2	2							

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Topic 3. Analysis of Stress and Strain in the case of the off-centre acting of force of tension or compression	11	8	2		2	2							
Topic 4. Analysis of Stress and Strain in the case of combined bending and torsion at once	12	7	2	2	2	2							
Topic 5. The calculation method of column.	13	8	2		2	2							
Topic 6. Analysis of Stress and Strain in the cases of acting difference types of dynamic loads	15	8	2	2	2	2							
Topic 7. Analysis of Stress and Strain in the cases of acting difference types of dynamic loads	15	8	2	1	2	2							
Total of module 5		53	14	7	14	14							
Total hour for Semester 4		105	30	15	30	30							
Total hours		210	75	30	45	60							

3. Topics of Lectures

№	Topic title	Hour numbers
3 semester		
1	Purpose and objectives of the course. The basic hypotheses and the definitions of the mechanics of materials and constructions.	2
2	The relation among internal forces and tensions in case of tension or compression of the bar.	2
3	The method of calculating the bar on strength	2
4	The method of calculating the bar on rigidity	2
5	The calculation of bar on strength with in terms of weight and temperature.	2
6	The calculation of statically indeterminate bars.	2
7	The geometric characterizations of the plane cross sections.	6
8	Analysis of Stress and Strain	4
9	The direct shear stresses.	2
10	The definition of torsion.	2
11	The method of calculating the bar on strength and rigidity by torsion	2
12	The equation of Shearing force for the cantilever and simple beams	2

13	The equation of Bending moment for the cantilever and simple beams.	2
14	The calculation method cantilever beam on the strength by the normal stresses	2
15	The calculation method simple beam on the strength by the normal stresses.	2
16	The definition of supports reaction of curveted beam	2
17	The building of diagrams of internal efforts for a curveted beam	3
18	Double – integration method	2
19	Verescagin´s rule.	2
4 semester		
1	The Castilian's theorem.	2
2	The More's integral.	2
3	The construction method of the diagram of shear-force and bending-moment for the cantilever frame	2
4	The construction method of the diagram of shear-force and bending-moment for the simple frame.	2
5	The definitions of the statically indeterminate constructions.	2
6	The application of the Castigliano´s theorem to the statically indeterminate constructions.	2
7	The three moment's theorem.	2
8	The application of the Verescagin´s rule to the statically indeterminate constructions.	2
9	Analysis of Stress and Strain in the case of combined bending and tension or compression	2
10	Analysis of Stress and Strain in the case of a complex bending	2
11	Analysis of Stress and Strain in the case of the off-centre acting of force of tension or compression	2
12	Analysis of Stress and Strain in the case of combined bending and torsion at once	2
13	The calculation method of column.	2
14	Analysis of Stress and Strain in the cases of acting difference types of dynamic loads	2
15	Analysis of Stress and Strain in the cases of acting difference types of dynamic loads	2

4.1 Topics of Practical classes

№	Topic title	Hour numbers
3 semester		
1	The construction of diagrams of normal force and normal stress for the bar	2
2	The calculation of the bar on strength and rigidity.	2
3	The geometric characterizations of the plane cross sections.	3
4	The method of calculating the bar on strength and rigidity by torsion.	2
5	The construction of diagram of Shearing force for the cantilever and simple beams.	2
6	The construction of diagram of Bending moment for the cantilever and simple beams.	2
7	The calculation of beams on the strength by the normal stresses.	2
4 semester		
1	The calculation of beam strain by Verescagin´s rule and by the Castigliano´s theorem.	4
2	The construction of the diagrams of shear-force and bending-moment for the difference types of frame	2
3	The curveted beam.	2
4	The calculation of the statically indeterminate constructions by difference	2

	methods.	
5	The calculation of beam in the case of at one time action of bending and torsion.	3
6	The calculation of column.	2

4.2Topics of laboratory classes

№	Topic title	Hour numbers
3 semester		
1	The determination of mechanical characteristics of "soft" steel in tension	4
2	The experimental calculation of the modulus of elasticity for steel	4
3	The experimental study of wood by compression	4
4	The investigation of the stress state by strain gauge	3
4 semester		
1	The experimental study of steel by compression	4
2	The determination of the modulus of elasticity for plastics	4
3	The experimental determination of Poisson's ratio for steel.	4
4	The study of the resistance of various structural materials on shear.	4
5	The study of the conceptions of building of diagrams of internal forces for beams by the mathematical modeling method	4
6	The calculation statically indeterminate beams by the mathematical modeling method	4
7.	The study of the stress state of the frame by the mathematical modeling method.	4
8.	The investigation of steel on impact strength test	2

5 Topics for self-study

№	Topic title	Hour numbers
3 semester		
1	The calculation of the bar on strength and rigidity.	4
2	The geometric characterizations of the plane cross sections.	8
3	The direct shear stresses.	2
4	The method of calculating the bar on strength and rigidity by torsion.	6
5	The calculation of cantilever beam on the strength by the normal stresses.	5
6	The calculation of simple beam on the strength by the normal stresses.	5
4 semester		
1	The calculation of beam strain by Verescagin´s rule.	2
2	The calculation of beam strain by the Castigliano´s theorem.	2
3	The curveted beam.	2
4	The application of the Verescagin´s rule to the statically indeterminate constructions.	1
5	Analysis of Stress and Strain in the case of the action of compression and bending at one time	2
6	Analysis of Stress and Strain in the case of the action of tension and bending at one time	2
7	Analysis of Stress and Strain in the case of the action of two bending moments at one time, which acting in perpendicular planes	2
8	The calculation method of column.	2

6. Tools for assessing expected learning outcomes:

- exam;
- credit;
- module tests;
- graphic design works;presentation of laboratory and practical works;
- other types.

7. Teaching methods:

- verbal method (lecture, discussion, interview, etc.);
- practical method (laboratory, practical classes);
- visual method (illustration, demonstration);
- video method (remote, multimedia, web-based, etc.);
- self-study (completing assignments);
- individual research work;

8. Results assessment.

The student's knowledge is assessed by means of a 100-point scale converted into the national grades according to the "Exam and Credit Regulations at NULES of Ukraine" in force

8.1. Distribution of points by types of educational activities

Educational activity	Results	Assessment
3 semester		
Module 1. **Tension and compression**		
Practical work 1.	ELO 2, 7, 17. **Student should be know:** the basic hypotheses and the definitions of the mechanics of materials and constructions **Student should be able to:** built the diagrams of internal forces and tensions in case of tension or compression of the bar.	**8**
Practical work 2.		**8**
Practical work 3.		**8**
Laboratory work 1.		**8**
Laboratory work 2.		**8**
Module work 1.		**20**
Module work 2.		**30**
Testing Module 1		**10**
Total for module 1		**100**
Module 2. **Torsion**		
Practical work 4.	ELO 2, 7, 17. **Student should be know:** the main geometric characterizations of the plane cross sections; the relation among internal forces and tensions in cases of direct shear and torsion. **Student should be able to:** built the diagrams of internal forces and tensions in case of torsion of the bar.	**5**
Practical work 5.		**5**
Laboratory work 3.		**5**
Module work 3.		**40**
Module work 4.		**30**
Testing Module 2		**15**
Total for module 2		**100**

Module 3. **Beam bending**		
Practical work 6.	ELO 2, 7, 17. **Student should be know:** the equations of bending moment and shearing force for the cantilever and simple beams. **Student should be able to:** built the diagrams of internal forces and tensions in case of bending of the beam.	**10**
Practical work 7.		**10**
Laboratory work 4.		**15**
Module work 5.		**20**
Module work 6.		**30**
Testing Module 3		**15**
Total for module 3		**100**
Class work	**(M1 + M2 + M3)/3*0,7 ≤ 70**	
Credit		**30**
Total for 3 semester	**(Class work + credit) ≤ 100**	
Course project/work		**100**
4 semester		
Module 4. **Methods of defininding of beam deformations**		
Practical work 8.	ELO 2, 7, 17. **Student should be know:** the basis methods for definition the deformations of beam and frame. The definitions of the statically indeterminate constructions; the three moment's theorem. **Student should be able to:** define the deformations of beam and frame by different methods.	**10**
Practical work 9.		**10**
Practical work 10.		**10**
Laboratory work 5.		**15**
Laboratory work 6.		**15**
Laboratory work 7.		**15**
Laboratory work 8		**15**
Testing Module 4		**10**
Total for module 4		**100**
Module 5. **The complex deformations**		
Practical work 11.	ELO 2, 7, 17. **Student should be know:** Stress and Strain in the case of the action of complex deformations of construction. **Student should be able to:** calculate beam and frame by acting of complex Stress and Strain.	**10**
Practical work 12.		**10**
Practical work 13.		**10**
Laboratory work 9.		**10**
Laboratory work 10.		**10**
Laboratory work 11.		**10**
Laboratory work 12		**10**
Module work 7.		**20**
Testing Module 5		**10**
Total for module 5		**100**
Class work	**(M1 + M2)/2*0,7 ≤ 70**	
Exam		**30**
Total for 4 semester	**(Class work + credit) ≤ 100**	

8.2. Scale for assessing student's knowledge

Student's rating, points	National grading (exam/credits)
90-100	excellent
74-89	good
60-73	satisfactory
0-59	unsatisfactory

8.3. Assessment policy

Deadlines and exam retaking rules	*EXAMPLE:* works that are submitted late without valid reasons will be assessed with a lower grade. Module tests may be retaken with the permission of the lecturer if there are valid reasons (e.g. a sick leave).
Academic integrity rules	*EXAMPLE:* cheating during tests and exams is prohibited (including using mobile devices). Term papers and essays must have correct references to the literature used
Attendance rules	*EXAMPLE:* Attendance is compulsory. For good reasons (e.g. illness, international internship), training can take place individually (online by the faculty dean's consent)

9. Teaching and learning aids

1. e-learning course of the discipline

- https://elearn.nubip.edu.ua/course/view.php?id=3933;
- https://elearn.nubip.edu.ua/course/view.php?id=3934;

2. Mechanics of materials: Theory and Problems. Textbook / A. Kutsenko, M. Bondar, V. Pryshliak. 2d. Edition, – Kyiv, 2020. – 598 p.

10. Recommended sources of information

1. Beer F.P., Johnston E.R., et. al.: Mechanics of materials., 8th Edition, Graw – Hill.Inc., 2020. – 896 p.
3. John C.J., Ross C.T.F.: Strength of Materials and Structures. Arnold. – 719 p.
4. R. C. Hibbeler. Mechanics of Materials. The 7th Edition.pdf – 1724 p https://drive.google.com/file/d/0Bx1MM7wb0GgSR2tjV1lrVHpDTEU/view?resourcekey=0-DD5wLrtza9lI5b-rwDPHqg
4. Sharma S.C.: Strength_of_materials. Web Course. http://www.nptel.iitm.ac.in/courses/Webcourse-contents/IITROORKEE/strength%20of%20materials /homepage.htm
5. Educational videos of mechanics of materials https://www.bing.com/videos/search?q=mechanics+of+material+PDF&qpvt=mechanics+of+material+pdf&FORM=VDRE