**appx 2**
**to the order of march 23, 2023 № 244**

**THE NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE**

DEPARTMENT OF MECHANICS

**“CONFIRMED”**
Dean of Design and
Engineering Faculty
_______________ Zinoviy RUZHYLO
„16” May 2023

**“APPROVED”**
at a meeting of the department of mechanics
Protocol № 9 of “25” April 2023
Chief of Department
_______________ Volodymyr BULGAKOV

**REVIEWED**
Program Coordinator
_______________ Yevhen DMYTRENKO

# WORK PROGRAM OF THE EDUCATIONAL DISCIPLINE

## "Mechanics of materials and constructions"

| | |
|---|---|
| Specialty | 192 "Building and civil engineering" |
| Educational program | Building and civil engineering |
| Faculty | Design and Engineering |
| Developer: | Anastasiia KUTSENKO., Ph. D. of Physical and Mathematical Sciences, Assoc. Prof. |

Kyiv 2023

## 1. Description of the discipline

**Mechanics of materials and constructions**

(title)

| Areas of knowledge, direction of training, speciality, education and qualification level | | |
|---|---|---|
| For ED | Bachelor | |
| Knowledge area | 19 "Architecture and construction" | |
| Speciality | 192 " Building and engineering of the city" | |
| Specialization | - | |
| Discipline characterization | | |
| Type | Obligatory | |
| Total number of hours | 165 | |
| Number of credits ECTS | 5,5 | |
| Number of thematic modules | 5 | |
| Form of control | *test /examination* | |
| Indicators of the discipline for daily learning | | |
| Year of study (course) | 2 | |
| Semester | 3 | 4 |
| Lectures | *30* hours. | *30* hours. |
| Practical, seminar classes | *30* hours. | *30* hours. |
| Laboratory lesson | -. | - |
| Independent study | *30* hours. | *15* hours. |
| Coursework | *30* hours. | |
| Number of weekly classroom hours for daily learning | 4 hours. | *4* hours. |

## 2. The purpose and objectives of the course

Purpose is skills of solving problems of Mechanics of materials and structures and laying the basis for the study subjects: "Structural mechanics", "Concrete and masonry structures", "Metal and wooden structures".

**Objectives:**

**-** Study of the methods of calculation of structures for strength, rigidity and stability;

- Study of the stress-strain state of the beam at tension and compression, at direct shear, at torsion and at bending;

A result of studying of discipline the student should:

**know**:

- The basic hypotheses and methods, which are used of calculations for strength, rigidity and stability of elements of buildings;
- The methods of determining the internal forces factors in statically determinate and statically indeterminate elastic systems;

- The relation among external forces and stresses and displacements in the different kind of simple and complex deformations.

**be able:**

- To choose the optimal variants of calculation schemes of the elements of constructions;
- To combine calculations into one whole for the building;
- To choose the rational structural materials and the economic sizes of the cross section of the elements of construction.

The discipline provides the following competencies:
- integral competencies (IC):

IC. It is the ability to solve complex specialized problems of construction and civil engineering in the learning process, which involves the application of a complex of theories and methods for determining the strength, stability, deformation, modeling, strengthening of building structures; further safe operation, reconstruction, construction and installation of buildings and engineering structures; application of automated design systems in the branch of construction.

- general competencies (GC):

GC1 – The ability to think abstractly, analyze and synthesize.

GC2 - The knowledge and understanding of the subject area and professional activity.

GC6 – The ability to search, to process and to analyze information from various sources.

GC7 –The interpersonal skills.

special competencies (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.

***Program results of learning(PRL)***:

PRL2 – The participate in research and development in the branch of architecture and construction.

PRL7 – The collect, the interpret and an apply data, including through the search, processing and analysis of information from various sources.

PRL11 – The avaluation of compliance of projects with design principles urban areas and infrastructure facilities and urban economy.

**3. The program and structure of discipline for**

- full term daily/distance learning first year students in 3 and 4 semesters 2023/2024 academic year

| Title of thematic modules and themes | 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 |
| The thematic module 1. **Tension and Compression** | | | | | | | | | | | | | |
| Theme 1. Purpose and objectives of the course. The basic hypotheses and the definitions of the mechanics of materials and constructions. | 1 | 2 | 2 | | | | | | | | | | |
| Theme 2. The relation among internal forces and tensions in case of tension or compression of the bar. | 2 | 6 | 2 | 2 | | 2 | | | | | | | |
| Theme 3. The method of calculating the bar on strength | 3 | 8 | 2 | 4 | | 2 | | | | | | | |
| Theme 4. The method of calculating the bar on rigidity | 4 | 6 | 2 | 2 | | 2 | | | | | | | |
| Theme 5. The first moment of area | 5 | 8 | 2 | 2 | | 4 | | | | | | | |
| Total for thematic module 1 | | 30 | 10 | 10 | | 10 | | | | | | | |
| The thematic module 2. **Torsion** | | | | | | | | | | | | | |
| Theme 1. The geometric characterizations of the plane cross sections. | 6 | 6 | 2 | 2 | | 2 | | | | | | | |
| Theme 2. The geometric characterizations of the plane cross sections. | 7 | 4 | 2 | 2 | | | | | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Theme 3. The direct shear stresses. | 8 | 6 | 2 | 2 | | 2 | | | | | | | |
| Theme 4. The definition of torsion. | 9 | 6 | 2 | 2 | | 2 | | | | | | | |
| Theme 5. The method of calculating the bar on strength and rigidity by torsion | 10 | 8 | 2 | 2 | | 4 | | | | | | | |
| Total for thematic module 2 | | 30 | 10 | 10 | | 10 | | | | | | | |
| The thematic module 3. **Beam bending** | | | | | | | | | | | | | |
| Theme 1. The equation of Shearing force for the cantilever and simple beams | 11 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 2. The equation of Bending moment for the cantilever and simple beams. | 12 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 3. The calculation method cantilever beam on the strength by the normal stresses | 13 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 4. The calculation method simple beam on the strength by the normal stresses. | 14 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 5. The calculation method simple beam on the strength by the normal stresses. | 15 | 6 | 2 | | 2 | 2 | | | | | | | |
| Total for thematic module 3 | | 30 | 10 | | 10 | 10 | | | | | | | |
| Total for Semester 3 | | 90 | 30 | | 30 | 30 | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| The thematic module 4**. Methods of defininding of beam deformations** | | | | | | | | | | | | | |
| Theme 1. Double – integration method. | 1 | 6 | 2 | | 2 | | | | | | | | |
| Theme 2. Verescagin´s rule. | 2 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 3. Castigliano´s theorem. | 3 | 4 | 2 | | 2 | 2 | | | | | | | |
| Theme 4. The construction method of the diagram of shear-force and bending-moment for the cantilever frame | 4 | 4 | 2 | | 2 | | | | | | | | |
| Theme 5. The construction method of the diagram of shear-force and bending-moment for the simple frame. | 5 | 4 | 2 | | 2 | | | | | | | | |
| Theme 6. The curveted beam. | 6 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 7. The definitions of the statically indeterminate constructions. | 7 | 4 | 2 | | 2 | | | | | | | | |
| Theme 8. The application of the Castigliano´s theorem to the statically indeterminate constructions. | 8 | 4 | 2 | | 2 | | | | | | | | |
| Total for thematic module 4 | | 38 | 16 | | 16 | 6 | | | | | | | |
| The thematic module 5. **The complex deformations** | | | | | | | | | | | | | |
| Theme 1. The three moment’s theorem. | 9 | 4 | 2 | | 2 | | | | | | | | |
| Theme 2. The application of the Verescagin´s rule to the statically indeterminate constructions. | 10 | 5 | 2 | | 2 | 1 | | | | | | | |
| Theme 3. Analysis of Stress and Strain in the case of the action of compression and bending at one time | 11 | 6 | 2 | | 2 | 2 | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Theme 4. Analysis of Stress and Strain in the case of the action of tension and bending at one time | 12 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 5. Analysis of Stress and Strain in the case of the action of two bending moments at one time, which acting in perpendicular planes | 13 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 6. The calculation method of column. | 14 | 6 | 2 | | 2 | 2 | | | | | | | |
| Theme 7. Analysis of Stress and Strain in the case of the action of bending and torsion at one time. | 15 | 6 | 2 | | 2 | | | | | | | | |
| Total for thematic module 5 | | 37 | 14 | | 14 | 9 | | | | | | | |
| Total for Semester 4 | | 75 | 30 | | 30 | 15 | | | | | | | |
| Total of hours | | 165 | 60 | | 60 | 45 | | | | | | | |

## 4. Lecture themes

| № | Theme 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 geometric characterizations of the plane cross sections. | 4 |
| 6 | The geometric characterizations of the plane cross sections. | 2 |
| 7 | Analysis of Stress and Strain. | 2 |
| 8 | The direct shear stresses. | 2 |
| 9 | The definition of torsion. | 2 |
| 10 | The method of calculating the bar on strength and rigidity by torsion. | 2 |
| 11 | The equation of Shearing force for the cantilever and simple beams. | 2 |
| 12 | The equation of Bending moment for the cantilever and simple beams. | 2 |
| 13 | The calculation method cantilever beam on the strength by the normal stresses. | 2 |
| 14 | The calculation method simple beam on the strength by the normal stresses. | 2 |
| | 4 semester | |
| 1 | Verescagin´s rule. | 2 |
| 2 | The method of initial parameters. | 2 |
| 3 | Castigliano´s theorem. | 2 |
| 4 | The construction method of the diagrams of shear-force and bending-moment for | 2 |

| | | |
|---|---|---|
| | the cantilever frame | |
| 5 | The construction method of the diagrams of shear-force and bending-moment for the simple frame. | 2 |
| 6 | The curveted beam. | 2 |
| 7 | The definitions of the statically indeterminate constructions. | 2 |
| 8 | The application of the Castigliano´s theorem to the statically indeterminate constructions. | 2 |
| 9 | The three moment's theorem. | 2 |
| 10 | The application of the Verescagin´s rule to the statically indeterminate constructions. | 2 |
| 11 | Analysis of Stress and Strain in the case of the action of compression and bending at one time | 2 |
| 12 | Analysis of Stress and Strain in the case of the action of tension and bending at one time | 2 |
| 13 | Analysis of Stress and Strain in the case of the action of two bending moments at one time, which acting in perpendicular planes | 2 |
| 14 | The calculation method of column. | 2 |
| 15 | Analysis of Stress and Strain in the case of the action of bending and torsion at one time. | 2 |

## 5. Practical, seminar work themes

| № | Theme title | Hour numbers |
|---|---|---|
| | 3 semester | |
| 1 | The calculation of the bar on strength. | 2 |
| 2 | The calculation of the bar on rigidity. | 2 |
| 3 | The geometric characterizations of the plane cross sections. | 6 |
| 4 | The direct shear stresses. | 2 |
| 5 | | 2 |
| 6 | The method of calculating the bar on strength and rigidity by torsion. | 2 |
| 7 | The construction of diagram of Shearing force for the cantilever and simple beams. | 2 |
| 8 | The construction of diagram of Bending moment for the cantilever and simple beams. | 2 |
| 9 | The calculation of cantilever beam on the strength by the normal stresses. | 4 |
| 10 | The calculation of simple beam on the strength by the normal stresses. | 4 |
| | 4 semester | |
| 1 | The calculation of beam strain by Verescagin´s rule. | 2 |
| 2 | The calculation of beam strain by the method of initial parameters. | 2 |
| 3 | The calculation of beam strain by the Castigliano´s theorem. | 2 |
| 4 | The construction of the diagrams of shear-force and bending-moment for the cantilever frame | 2 |
| 5 | The construction of the diagrams of shear-force and bending-moment for the simple frame. | 2 |
| 6 | The curveted beam. | 2 |
| 7 | The definitions of the statically indeterminate constructions. | 2 |
| 8 | The application of the Castigliano´s theorem to the statically indeterminate constructions. | 4 |
| 9 | The three moment's theorem. | 2 |
| 10 | The application of the Verescagin´s rule to the statically indeterminate constructions. | 4 |

| | | |
|---|---|---|
| 11 | The calculation of column. | 2 |
| 12 | The calculation of beam in the case of at one time action of bending and torsion. | 4 |

## 6. The independent work themes

| № | Theme 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 |

## 7. Test questions and test sets for determine of the level assimilation of knowledge by students.

**Question 1.**

| | **The basic objects of subject of mechanics of materials are:** |
|---|---|
| 1. | Bar, rivet, beam |
| 2. | Bar, shaft, beam |
| 3. | Squared beam, shell, array |
| 4. | Screw, key, shaft |

**Question 2.**

| | **The basic problem of mechanics of materials consists in:** |
|---|---|
| 1. | determining sizes of detail from conditions of durability |
| 2. | determining mechanics properties of material |
| 3. | calculation stresses by bending |
| 4. | determining sizes of detail from conditions of durability and rigidity |

**Question 3.**

| | **Give determination of deformation** |
|---|---|
| 1. | displacement and torsion |
| 2. | change of form and sizes of detail |
| 3. | relative displacement of cross-sections of detail under bending |
| 4. | relative displacement of cross-sections of detail under shear |

**Question 4.**

| | **Stresses are** |
|---|---|
| 1. | external force, which loads on the surface of detail |
| 2. | internal force, which loads on unit of area |
| 3. | twisting moment, which shaft loads |
| 4. | bending moment, which beam loads |

**Question 5.**

| | **Give the list of simple deformations** |
|---|---|
| 1. | direct shear, torsion, displacement |
| 2. | tension (compression), direct shear, torsion, bending |
| 3. | displacement, bending, direct shear |
| 4. | torsion, displacement, bending, direct shear |

**Question 6.**

| | **Hooke's Law by extension has form:** |
|---|---|
| 1. | $\sigma = \mu \cdot E$ |
| 2. | $\tau = j \cdot E$ |
| 3. | $\sigma = \varepsilon \cdot E$ |
| 4. | $\sigma = \dfrac{M}{W_y}$ |

**Question 7.**

| | **For the plastic materials the legitimate stresses determine by formula:** |
|---|---|
| 1. | $[\sigma] = \dfrac{\sigma_{пр}}{k_{пр}}$ |
| 2. | $[\sigma] = \dfrac{\sigma_{пл}}{k_{пл}}$ |
| 3. | $[\sigma] = \dfrac{\sigma_{мц}}{k_{мц}}$ |
| 4. | $[\sigma] = \dfrac{\sigma_{руйн}}{k_{руйн}}$ |

**Question 8.**

| | **The bar of constant cross section must be loaded by …….., this bar will compressed** |
|---|---|
| 1. | twisting moment |
| 2. | bending moment |
| 3. | shearing force |
| 4. | normal force |
| 5. | uniformly distributed loads |

**Question 9.**

| | **For the fragile materials the legitimate stresses determine by formula:** |
|---|---|
| 1. | $\left[\sigma\right]=\frac{\sigma_{пр}}{k_{пр}}$ |
| 2. | $\left[\sigma\right]=\frac{\sigma_{пл}}{k_{пл}}$ |
| 3. | $\left[\sigma\right]=\frac{\sigma_{мц}}{k_{мц}}$ |
| 4. | $\left[\sigma\right]=\frac{\sigma_{руйн}}{k_{руйн}}$ |

**Question 10.**

| | **What is bar?** |
|---|---|
| 1. | Squared beam which has one size is biggest than other two and works on tension or compression |
| 2. | Squared beam which has one size is biggest than other two and works on torsion |
| 3. | Squared beam which has one size is biggest than other two and works on bending |
| 4. | The element of construction, which is limited two parallel planes and it has one size is biggest than other two |

**Question 11.**

| | **The condition of durability under tension or compression is** |
|---|---|
| 1. | $\sigma_{\max}=\frac{N_{\max}}{A}\leq\left[\sigma\right]$ |
| 2. | $\tau_{\max}=\frac{N_{\max}}{A}\leq\left[\tau\right]$ |

| | |
|---|---|
| 3. | $\sigma_{\max} = \dfrac{N_{\max}}{A} \geq [\sigma]$ |
| 4. | $\tau_{\max} = \dfrac{N_{\max}}{A} \geq [\tau]$ |

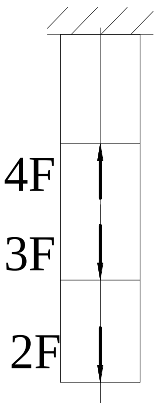
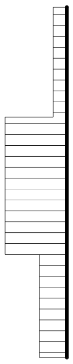
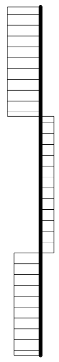
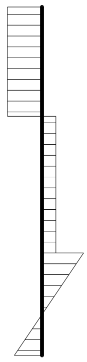
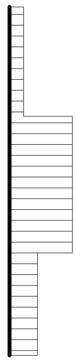
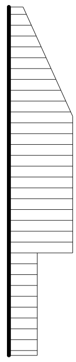
**Question 12.**

| | **The condition of rigidity under tension or compression is** |
|---|---|
| 1. | $\sigma_{\max} = \dfrac{N_{\max}}{A} \leq [\sigma]$ |
| 2. | $\tau_{\max} = \dfrac{N_{\max}}{A} \leq [\tau]$ |
| 3. | $\sigma_{\max} = \dfrac{N_{\max}}{A} \geq [\sigma]$ |
| 4. | $\tau_{\max} = \dfrac{N_{\max}}{A} \geq [\tau]$ |
| 5. | $[\Delta l] \leq \Delta l = \sum \int \dfrac{N(x)}{EA(x)}$ |
| 6. | $\Delta l = \sum \int \dfrac{N(x)dx}{EA(x)} \leq [\Delta l]$ |

**Question 13.**

| | **The isotropic material is called:** |
|---|---|
| | Material, points of which have equal properties |
| | Material, all points of which have equal properties in certain direction |
| | Material, all points of which have equal properties in arbitrary direction |
| | Material, all points of which have equal properties in cross direction |

**Question 14.**

| | **What diagram of normal force is true?** | | | | |
|---|---|---|---|---|---|
|  |  |  |  |  |  |
| | 1 | 2 | 3 | 4 | 5 |

**Question 15.**

| | |
|---|---|
| | **The cross section of bar must satisfy to conditions of durability and rigidity. From the condition of durability the diameter of bar must be equal 30 mm and from condition of rigidity is 50 mm. What size it follows to accept the diameter of bar?** |
| 1. | d=30 mm |
| 2. | d=50 mm |
| 3. | d=40 mm |
| 4. | d=80 mm |
| 5. | d=60 mm |

**Question 16.**

| | |
|---|---|
| | **What does exist connection between the modules $G$ and $E$?** |
| 1. | $G = \frac{E}{(1+\mu)}$ |
| 2. | $G = \frac{E}{2(1+\mu)}$ |
| 3. | $G = \frac{2E}{(1+\mu)}$ |
| 4. | $G = \frac{E}{3(1+\mu)}$ |

**Question 17.**

| | |
|---|---|
| | **What is loads does create deformation of torsion?** |
| 1. | twisting moment |
| 2. | bending moment |
| 3. | shearing force |
| 4. | normal force |
| 5. | uniformly distributed loads |

**Question 18.**

| | |
|---|---|
| | **The condition of durability of riveting connection looks like on a cut:** |
| | $\tau_{зр} = \frac{N}{mn\pi d^2} \leq [\tau]$ |
| | $\tau_{зр} = \frac{N}{mn\frac{\pi d^2}{16}} \leq [\tau]$ |

| | |
|---|---|
| | $\tau_{зр} = \dfrac{N}{mn\dfrac{\pi d^2}{4}} \le [\tau]$ |
| | $\tau_{зр} = \dfrac{N}{\dfrac{\pi d^2}{4}} \le [\tau]$ |

**Question 19.**

| | **What is shaft?** |
|---|---|
| 1. | Squared beam which has one size is biggest than other two and works on tension or compression |
| 2. | Squared beam which has one size is biggest than other two and works on torsion |
| 3. | Squared beam which has one size is biggest than other two and works on bending |
| 4. | The element of construction, which is limited two parallel planes and it has one size is biggest than other two |

**Question 20.**

| | **Hooke's Law of torsion has form:** |
|---|---|
| 1. | $\sigma = EF$ |
| 2. | $\sigma = G\gamma$ |
| 3. | $\tau = EF$ |
| 4. | $\tau = E\varepsilon$ |
| 5. | $\sigma = El$ |
| 6. | $\tau = G\gamma$ |

**Question 21.**

| | The condition of durability for shaft at twisting is: |
|---|---|
| 1. | $\tau_{\max} = \dfrac{M_\kappa}{W_x} \le [\tau]$ |
| 2. | $\tau_{\max} = \dfrac{M_\kappa}{W_y} \le [\tau]$ |
| 3. | $\sigma_{\max} = \dfrac{M_\kappa}{W_x} \le [\sigma]$ |
| 4. | $\tau_{\max} = \dfrac{M_\kappa}{W_\rho} \le [\tau]$ |

**Question 22.**

| | The angle of twist is calculate by formula: |
|---|---|
| 1. | $\varphi = \dfrac{GI_\rho}{M_\kappa l}$ |
| 2. | $\varphi = \dfrac{M_\kappa l}{GI_\rho}$ |
| 3. | $\varphi = \dfrac{G}{M_\kappa l}$ |
| 4. | $\varphi = \dfrac{P}{GI_\rho}$ |

**Question 23.**

| | If diameter round transversal a cut to increase in 2 times, the axial moment of inertia will be increased in: |
|---|---|
| 1. | 2 times |
| 2. | 4 times |
| 3. | 8 times |
| 4. | 16 times |
| 5. | 32 times |

**Question 24.**

| | The condition of rigidity for shaft at twisting is: |
|---|---|
| 1. | $\varphi_{\max} = \dfrac{GI_\rho}{M_\kappa l} \le [\varphi]$ |
| 2. | $\varphi_{\max} = \dfrac{M_\kappa l}{GI_\rho} \le [\varphi]$ |
| 3. | $\varphi_{\min} = \dfrac{G}{M_\kappa l} \le [\varphi]$ |
| 4. | $\varphi_{\min} = \dfrac{P}{GI_\rho} \le [\varphi]$ |

**Question 25.**

| | Why the polar moment of inertia for a circle is equal? |
|---|---|
| 1. | $I_\rho = \dfrac{\pi d^2}{64}$ |

| | |
|---|---|
| 2. | $I_\rho = \frac{\pi d^3}{32}$ |
| 3. | $I_\rho = \frac{\pi d^4}{32}$ |
| 4. | $I_\rho = \frac{2\pi d}{64}$ |

**Question 26.**

| | Per unity of moments of inertia is: |
|---|---|
| 1. | $m^4$ |
| 2. | N · m |
| 3. | $m \cdot c^2$ |
| 4. | $m^3$ |
| 5. | m · c |

**Question 27.**

| | **The coordinates of centroid are calculate by formula:** |
|---|---|
| 1. | $x_c = \frac{\sum I_y}{\sum I_x},\ y_c = \frac{\sum I_x}{\sum I_y}$ |
| 2. | $x_c = \frac{\sum S_y}{\sum S_x},\ y_c = \frac{\sum S_x}{\sum S_y}$ |
| 3. | $x_c = \frac{\sum S_x}{\sum A},\ y_c = \frac{\sum S_y}{\sum A};$ |
| 4. | $x_c = \frac{\sum S_y}{\sum A},\ y_c = \frac{\sum S_x}{\sum A}$ |
| 5. | $x_c = \frac{\sum S_x + S_y}{\sum A},\ y_c = \frac{\sum S_x - S_y}{\sum A}$ |

**Question 28.**

| | **If a rectangle has a height of $h = 6$ cm, and width of $b = 4$ cm, so maximal axial moment of inertia about central axes of such rectangular cross section is equal:** |
|---|---|
| 1. | $20$ $cm^4$ |
| 2. | $36$ $cm^4$ |
| 3. | $42$ $cm^4$ |
| 4. | $54$ $cm^4$ |
| 5. | $72$ $cm^4$ |

**Question 29.**

| | **What is beam?** |
|---|---|
| 1. | Squared beam which has one size is biggest than other two and works on tension or compression |
| 2. | Squared beam which has one size is biggest than other two and works on torsion |
| 3. | Squared beam which has one size is biggest than other two and works on bending |
| 4. | The element of construction, which is limited two parallel planes and it has one size is biggest than other two |

**Question 30.**

| | How many reactions must be in point of beam, which simply supported? |
|---|---|
| 1. | two |
| 2. | three |
| 3. | four |
| 4. | five |

**Question 31.**

| | How many reactions must be in point of beam, which rigidly fixed? |
|---|---|
| 1. | one |
| 2. | two |
| 3. | three |
| 4. | four |
| 5. | five |

**Question 32.**

| | The maximal value of normal stresses at bending of beam is calculated by formula? |
|---|---|
| 1. | $\sigma_{\max} = \frac{M_{\max}}{W_y}$ |
| 2. | $\tau_{\max} = \frac{M_{\min}}{W_y}$ |
| 3. | $\sigma_{\max} = \frac{M_{\min}}{W_x}$ |
| 4. | $\tau_{\max} = \frac{M_{\max}}{W_\rho}$ |

**Question 33.**

| | What bendings do arise up in hinge support? |
|---|---|
| 1. | maximal |
| 2. | zero |
| 3. | minimal |
| 4. | unity |

**Question 34.**

| | What is a formula of calculation shearing stresses at the bend of beam? |
|---|---|
| 1. | $\tau = \dfrac{Q_x S(z)}{I_y b}$ |
| 2. | $\sigma = \dfrac{M_x S(z)}{I_y b}$ |
| 3. | $M = \dfrac{Q_x S(z)}{I_y}$ |
| 4. | $\tau = \dfrac{I_y b}{Q_x S(z)}$ |

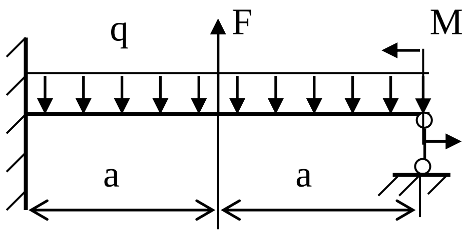
**Question 35.**

| | The differential equation of the deflection curve of a beam has form: |
|---|---|
| 1. | $EI\dfrac{d^3 y}{dx^3} = M_x$ |
| 2. | $EI\dfrac{dy}{dx} = M_x$ |
| 3. | $EI\dfrac{d^3 y}{dx^2 dz} = M_x$ |
| 4. | $EI\dfrac{d^2 y}{dx^2} = M_x$ |
| 5. | $EI\dfrac{d^2 y}{dx dz} = M_x$ |

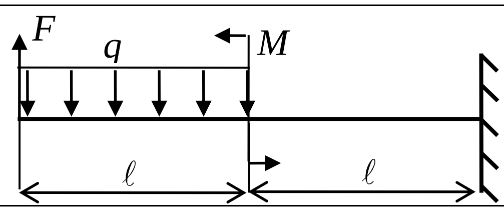
**Question 36.**

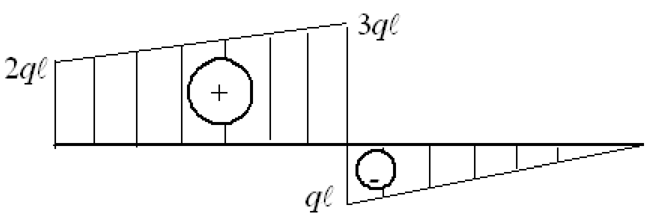
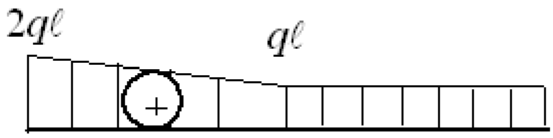
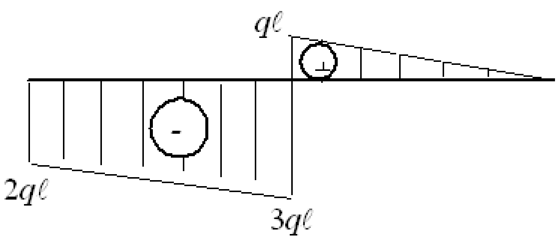
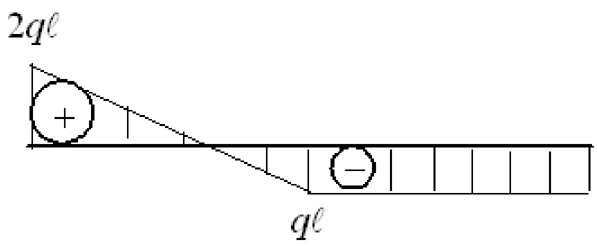
| | **What is basic in Verescagin's rule?** |
|---|---|
| 1. | Integration of diagrams |
| 2. | Differentiation of diagrams |
| 3. | Multiplying of diagrams |
| 4. | Deduction of diagrams |
| 5. | Division of diagrams |

**Question 37.**

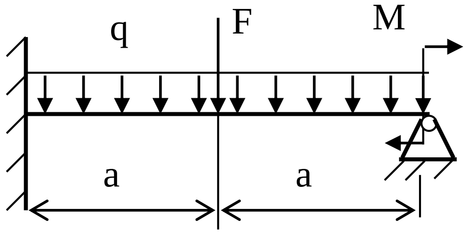
| | |
|---|---|
| | Given beam is:  |
| 1. | one statically indeterminate system |
| 2. | two statically indeterminate system |
| 3. | three statically indeterminate system |
| 4. | statically determinate system |

**Question 38.**

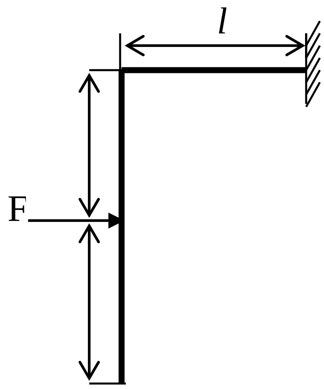
| | |
|---|---|
| | **Визначити правильну епюру поперечних сил для даної балки, якщо** $F = 2q\ell$**,** $M = 4q\ell^2$**?**  |

| | |
|---|---|
| 1  | 3  |
| 2  | 4  |

**Question 39.**

| | |
|---|---|
| | Given beam is:  |
| 1. | one statically indeterminate system |
| 2. | two statically indeterminate system |
| 3. | three statically indeterminate system |
| 4. | statically determinate system |

**Question 40.**

| | |
|---|---|
| | Given frame is:  |
| 1. | one statically indeterminate system |
| 2. | two statically indeterminate system |
| 3. | three statically indeterminate system |
| 4. | statically determinate system |

## 8. Education methods.

1) Verbal:
   - Lectures;
2) Visual:
   - Slides, video, visual material (perts, charts, stands).
3) Practical:
   - Training and factory practices;
   - Independent work.

**9. Forms control.**

- indeoendent work;
- module test;
- test;
- examination.

**10.Distribution points that receive students.** The student evaluation done in accordance with the provision «Про екзамени та заліки у НУБіП України» від 20.02.2015 р. протокол № 6 з табл. 1.

| National estimation | Estimation ECTS | Definition of estimation ECTS | Student rating, points |
|---|---|---|---|
| **Excellent** | **A** | **EXCELLENT -** excellent performance with few errors | **90 – 100** |
| **Good** | **B** | **VERY GOOD -** higher middle level with some mistakes | **82 – 89** |
| | **C** | **GOOD -** generally correct work with a number of few gross errors | **74 – 81** |
| **Satisfactory** | **D** | **Satisfactory -** not bad but many drawbacks | **64 – 73** |
| | **E** | **ENOUGH -** implementation satisfies minimum criteria | **60 – 63** |
| **Unsatisfactorily** | **FX** | **UNSATISFACTORILY** – need to work before get credit (positive evaluation) | **35 – 59** |
| | **F** | **UNSATISFACTORILY** – serious further work is needed | **01 – 34** |

The student rating (listener) of the discipline $\mathbf{R_{ДИС}}$ (up to 100 points) to determine as sum rating received at attestation $\mathbf{R_{AT}}$ (up to 30 points) and the student (listener) rating for educational work $\mathbf{R_{HP}}$ (up to 70 points):

**10. Methodical provision**

- Textbooks and manuals;
- ENC Course: Mechanics of Materials and Constructions ☑ (nubip.edu.ua)

## 11. Recommended Literature

**- main:**

1. Beer F.P., Johnston E.R., et. al.: Mechanics of materials., 8th Edition, Graw – Hill. Inc., 2020. – 896 p.
2. Mechanics of materials: Theory and Problems. Textbook / A. Kutsenko, M. Bondar, V. Pryshliak. –Kyiv, 2018. – 598 p.

**– ancillary:**

1. John C.J., Ross C.T.F.: Strength of Materials and Structures. Arnold. – 719 p.
2. R.K. Rajput. A Textbook of Strength of Materials (Mechanics of Solids) in SI Units., 2018 – 1312 p.

## 12. Information Resources

https://www.youtube.com/
https://uk.wikipedia.org/wiki/
http://www.gntb.gov.ua/ua/
http://www.tib.uni-hannover.de/
http://www.bookshop.ua/