THE NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

DEPARTMENT OF MECHANICS

APPROVE:
Dean of Design and Engineering Faculty

_____Z. Ruzhylo
„_17_" ___05___ 2022

REVIEWED AND CONSIDERED
at a meeting of the department of mechanics
Protocol № 6 of "16" may 2022
Chief of Department

_____V. Bulgakov

REVIEWED
Guaretor of EP

_____V. Bulgakov

Educational - methodical complex
of the discipline

"Mechanics of materials and constructions"

Speciality 133 "Sectoral mechanical engineering"
Faculty Design and Engineering
Developer: A. Kutsenko., Ph. D. of Physical and Mathematical Sciences, Ass. Prof.

Kiev 2022

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WORK PROGRAM OF THE EDUCATIONAL DISCIPLINE

"Mechanics of materials and constructions"

Speciality 133 "Sectoral mechanical engineering
Faculty Design and Engineering
Developer: A. Kutsenko., Ph. D. of Physical and Mathematical Sciences, Ass. Prof.

Kiev 2022

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	13 "Mechanical engineering"	
Speciality	133 "Sectoral mechanical engineering"	
Specialization	-	
Discipline characterization		
Type	Obligatory	
Total number of hours	210	
Number of credits ECTS	7	
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	45hours.	*30* hours.
Practical, seminar classes	*15* hours.	*30* hours.
Laboratory lesson	*15* hours.	*15* hours -
Independent study	*15* hours.	*30* hours.
Coursework	- hours.	- hours.
Number of weekly classroom hours for daily learning	5 hours.	*5* 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: "Load-lifting machines "**,** "Building machinery"**,** "Machine elements"**.**

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, 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.

3. The program and structure of discipline for

- full term daily/distance learning first year students in 3 and 4 semesters 2021/2022 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	6	2		2	2							
Theme 2. The relation among internal forces and tensions in case of tension or compression of the bar.			2										
Theme 3. The method of calculating the bar on strength	2	6	2	2		2							
Theme 4. The method of calculating the bar on rigidity	3	10	2		2	2							
Theme 5. The			2										

calculation of bar on strength with in terms of weight and temperature.													
Theme 6. The calculation of statically indeterminate bars.	4	6	2	2		2							
Total for thematic module 1		28	12	4	4	8							
The thematic module 2. **Torsion**													
Theme 1. The geometric characterizations of the plane cross sections.	5	8	4		2	2							
Theme 1. The geometric characterizations of the plane cross sections.	6	6	2	2		2							
Theme 2. Analysis of Stress and Strain	7	8	4		2	2							
Theme 3. The direct shear stresses.	8	6	2	2		2							
Theme 4. The definition of torsion.	9	8	2		2	2							
Theme 5. The method of calculating the bar on strength and rigidity by torsion			2										
Total for thematic module 2		36	16	4	6	10							
The thematic module 3. **Beam bending**													
Theme 1. The equation of Shearing force for the cantilever and simple beams	10	6	2	2		2							
Theme 2. The equation of Bending moment for the cantilever and simple beams.	11	8	2		2	2							
Theme 3. The calculation method cantilever beam on the strength by the normal stresses			2										
Theme 4. The calculation method simple beam on the	12	6	2	2		2							

strength by the normal stresses.													
Theme 5. The definition of supports reaction of curveted beam	13	9	2		2	2							
Theme 5. The building of diagrams of internal efforts for a curveted beam			3										
Theme 6. Double – integration method	14	6	2	2		2							
Theme 7. Verescagin´s rule.	15	6	2	1	1	2							
Total for thematic module 3		41	17	7	5	12							
Total for Semester 3		105	45	15	15	30							
The thematic module 4**. Methods of definition of beam systems deformations**													
Theme 1. Castigliano´s theorem.	1	8	2	4		2							
Theme 2. The More's integral.	2	4	2			2							
Theme 3. The construction method of the diagram of shear-force and bending-moment for the cantilever frame	3	8	2	2	2	2							
Theme 4. The construction method of the diagram of shear-force and bending-moment for the simple frame.	4	6	2	2		2							
Theme 5. The definitions of the statically indeterminate constructions.	5	8	2	2	2	2							
Theme 6. The application of the Castigliano´s theorem to the statically indeterminate constructions.	6	6	2	2		2							
Theme 7. The three moment's theorem.	7	6	2	2		2							
Theme 8. The application of the Verescagin´s rule to	8	6	2	2		2							

the statically indeterminate constructions.													
Total for thematic module 4		52	16	16	4	16							
The thematic module 5**. Complex stresses**													
Theme 1. Analysis of Stress and Strain in the case of combined bending and tension or compression	9	8	2	2	2	2							
Theme 2. Analysis of Stress and Strain in the case of a complex bending	10	6	2		2	2							
Theme 3. Analysis of Stress and Strain in the case of the off-centre acting of force of tension or compression	11	8	2	4		2							
Theme 4. Analysis of Stress and Strain in the case of combined bending and torsion at once	12	7	2	2	1	2							
Theme 5. The calculation method of column.	13	8	2	2	2	2							
Theme 6. Analysis of Stress and Strain in the cases of acting difference types of dynamic loads	15	8	2	2	2	2							
Theme 6. Analysis of Stress and Strain in the cases of acting difference types of dynamic loads	15	8	2	2	2	2							
Total for thematic module 5		53	14	14	11	14							
Total for Semester 4		105	30	30	15	30							
Total of hours		210	75	30	45	60							

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 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	The double integration method.	2
19	Verescagin´s rule.	2
	4 semester	
1	Castigliano´s theorem.	2
2	The More's integral.	2
3	The construction method of the diagrams of shear-force and bending-moment for the cantilever frame	2
4	The construction method of the diagrams 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	4

5. Practical, seminar work themes

№	Theme 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.	6
2	The construction of the diagrams of shear-force and bending-moment for the difference types of frame	6
3	The curveted beam.	4
4	The calculation of the statically indeterminate constructions by difference methods.	4
5	The calculation of beam in the case of at one time action of bending and torsion.	6
6	The calculation of column.	4

6. Laboratory work themes

№	Theme 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	2
2	The determination of the modulus of elasticity for plastics	2
3	The experimental determination of Poisson's ratio for steel.	2
4	The study of the resistance of various structural materials on shear.	2
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	1
7.	The study of the stress state of the frame by the mathematical modeling method.	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.	$\sigma = \frac{M}{W_y}$

Question 7.

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

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.	$[\sigma] = \frac{\sigma_{пр}}{k_{пр}}$
2.	$[\sigma] = \frac{\sigma_{пл}}{k_{пл}}$
3.	$[\sigma] = \frac{\sigma_{мц}}{k_{мц}}$
4.	$[\sigma] = \frac{\sigma_{руйн}}{k_{руйн}}$

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.	$\sigma_{\max} = \frac{N_{\max}}{A} \le [\sigma]$
2.	$\tau_{\max} = \frac{N_{\max}}{A} \le [\tau]$
3.	$\sigma_{\max} = \frac{N_{\max}}{A} \ge [\sigma]$
4.	$\tau_{\max} = \frac{N_{\max}}{A} \ge [\tau]$

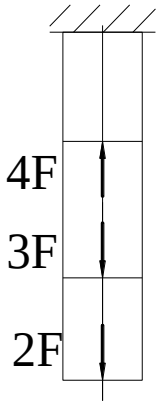
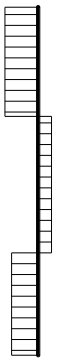
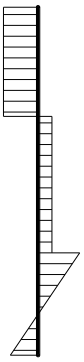
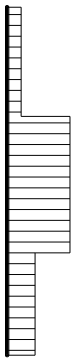
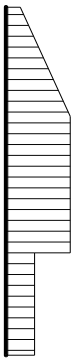
Question 12.

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

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:
	$\tau_{зр} = \frac{N}{mn\pi d^2} \le [\tau]$
	$\tau_{зр} = \frac{N}{mn\frac{\pi d^2}{16}} \le [\tau]$
	$\tau_{зр} = \frac{N}{mn\frac{\pi d^2}{4}} \le [\tau]$
	$\tau_{зр} = \frac{N}{\frac{\pi d^2}{4}} \le [\tau]$

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.	$\tau_{\max} = \frac{M_к}{W_x} \le [\tau]$
2.	$\tau_{\max} = \frac{M_к}{W_y} \le [\tau]$
3.	$\sigma_{\max} = \frac{M_к}{W_x} \le [\sigma]$
4.	$\tau_{\max} = \frac{M_к}{W_\rho} \le [\tau]$

Question 22.

	The angle of twist is calculate by formula:
1.	$\varphi = \frac{GI_\rho}{M_к l}$
2.	$\varphi = \frac{M_к l}{GI_\rho}$
3.	$\varphi = \frac{G}{M_к l}$
4.	$\varphi = \frac{P}{GI_\rho}$

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.	$\varphi_{\max} = \frac{GI_\rho}{M_\kappa l} \le [\varphi]$
2.	$\varphi_{\max} = \frac{M_\kappa l}{GI_\rho} \le [\varphi]$
3.	$\varphi_{\min} = \frac{G}{M_\kappa l} \le [\varphi]$
4.	$\varphi_{\min} = \frac{P}{GI_\rho} \le [\varphi]$

Question 25.

	Why the polar moment of inertia for a circle is equal?
1.	$I_\rho = \frac{\pi d^2}{64}$
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.	$N \cdot m$
3.	$m \cdot c^2$
4.	m^3
5.	$m \cdot c$

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.	$\tau = \frac{Q_x S(z)}{I_y b}$
2.	$\sigma = \frac{M_x S(z)}{I_y b}$
3.	$M = \frac{Q_x S(z)}{I_y}$
4.	$\tau = \frac{I_y b}{Q_x S(z)}$

Question 35.

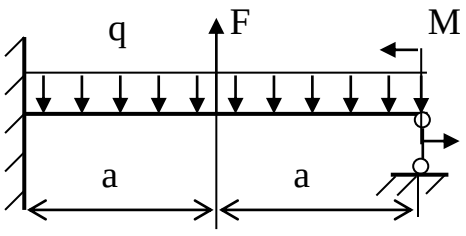
	The differential equation of the deflection curve of a beam has form:

1.	$EI\frac{d^3y}{dx^3}=M_x$
2.	$EI\frac{dy}{dx}=M_x$
3.	$EI\frac{d^3y}{dx^2dz}=M_x$
4.	$EI\frac{d^2y}{dx^2}=M_x$
5.	$EI\frac{d^2y}{dxdz}=M_x$

Question 36.

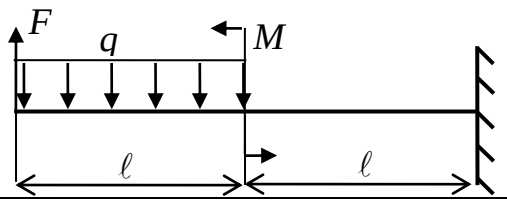
	What is basic in Verescagin's rule?
1.	Integration of diagrams
2.	Differentiation of diagrams
3.	Multiplying of diagrams
4.	Deduction of diagrams
5.	Division of diagrams

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 $F = 2q\ell$, $M = 4q\ell^2$**?**



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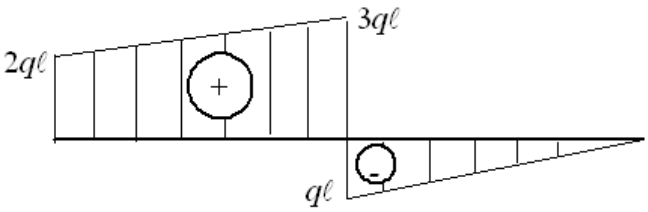

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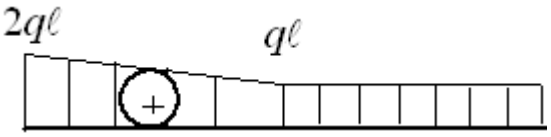
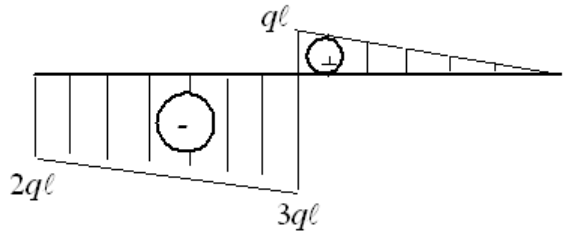
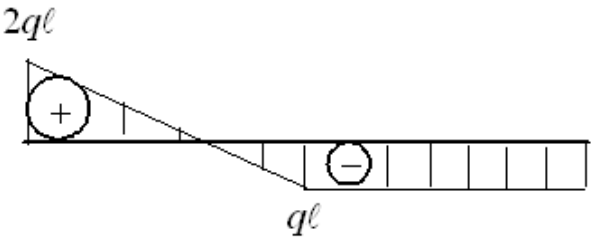


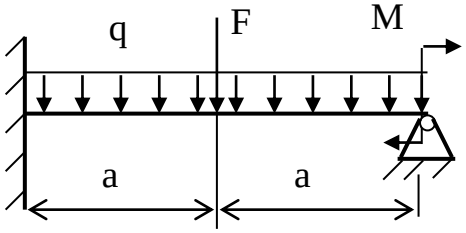
2



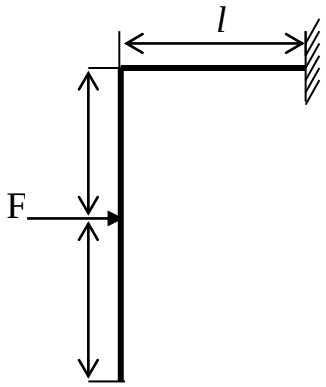
4



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.

- control work;
- module control work;
- 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;
- Guidelineses for laboratory works;
- Stands, posters;
- Equipment and various device.

11. Recommended Literature

- Main:

1. Mechanics of materials: Theory and Problems. Maual / A. Kutsenko, M. Bondar, V. Pryshliak. – Nizhyn: „Vidavnitstvo „Aspekt-Poligraf", 2016. – 360 p.

2. Mechanics of Materials and structures. Tutorial / M.G. Chausov, V.M. Shvayko, A.P. Pylypenko, M.M. Bondar, V.B. Berezin; edited by M.G. Chausov. – K: CP „Komprint", 2015. – 259 p.

3. Mechanics of materials: Theory and Problems. Textbook / A. Kutsenko, M. Bondar, V. Pryshliak. –Kyiv, 2018. – 598 p.

– ancillary:

1. Beer F.P., Johnston E.R., et. al.: Mechanics of materials., 8th Edition, Graw – Hill. Inc., 2020. – 896 p.

2. Bansal R. K.: Strength of Materials., 5th Edition, Laxmi Publications., 2014. – 1106 p.
3. John C.J., Ross C.T.F.: Strength of Materials and Structures. Arnold. – 719 p.
4. Dupen B.: Applied Strength of Materials for Engineering Technology. Indiana University - Purdue University Fort Wayne., 2014. – 151 p.
5. R.K. Rajput. A Textbook of Strength of Materials (Mechanics of Solids) in SI Units., 2018 – 1312 p.
6. Sohor M.: Strength_of_materials., 2011. – 210 p.
7. Sharma S.C.: Strength_of_materials. Web Course. http://www.nptel.iitm.ac.in/courses/Webcourse-contents/IITROORKEE/strength%20of%20materials /homepage.htm

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/