

**Ministry of Education and Science of Ukraine  
Dnipro University of Technology**

Department of Structural, Theoretical and Applied Mechanics

**"APPROVED"**

Head of Department

Kolosov D.L. 

June 30, 2020

**WORK PROGRAM OF THE ACADEMIC DISCIPLINE**

**"Strength of materials"**

Field of study.....	19 Architecture and construction
Specialty.....	192 Construction and Civil Engineering
Academic degree.....	Bachelor
Academic program.....	192 Construction and Civil Engineering
Type of discipline.....	Basic
Total workload.....	6 credits (180 hours)
Type of final assessment.....	exam
Period of study.....	3rd semester, 5,6 quarters
Language of study.....	English

Lecturer: Dolgov O.M.

Prolonged: for 20\_\_ / 20\_\_ academic year \_\_\_\_\_ (\_\_\_\_\_) " " 20\_\_  
(Signature, name, date)

for 20\_\_ / 20\_\_ academic year \_\_\_\_\_ (\_\_\_\_\_) " " 20\_\_  
(Signature, name, date)

Dnipro  
Dnipro University of Technology  
2020

Work program of the academic discipline “Strength of materials” for bachelors of specialty 192 Construction and Civil Engineering / O.M. Dolgov / Dnipro University of Technology, Dept. of Struct., Theor. and Appl. Mech. – Dnipro.: DUT, 2020. – 12 p.

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The work program regulates:

- key goals and objectives;
- the disciplinary learning outcomes generated through the transformation of the intended learning outcomes of the degree program;
- the content of the discipline formed according to the criterion “disciplinary learning outcomes”;
- the discipline program (thematic plan by different types of classes);
- distribution of the discipline workload by different types of classes;
- an algorithm for assessing the level of achievement of disciplinary learning outcomes (scales, tools, procedures and evaluation criteria);
- criteria and procedures for evaluating the academic achievements of applicants by discipline;
- the contents of the educational and methodological support of the discipline;

The work program is designed to implement a competency approach in planning an education process, delivery of the academic discipline, preparing students for control activities, controlling the implementation of educational activities, internal and external quality assurance in higher education, accreditation of degree programs within the specialty.

Approved by the decision of the Methodical Commission of specialty 192 Construction and Civil Engineering (protocol № 7, June 26, 2020).

## **CONTENTS**

1 DISCIPLINE OBJECTIVES .....	Error! Bookmark not defined.
2 INTENDED DISCIPLINARY LEARNING OUTCOMES.....	4
3 BASIC DISCIPLINES .....	4
4 WORKLOAD DISTRIBUTION BY THE FORM OF EDUCATIONAL PROCESS ORGANIZATION AND TYPES OF CLASSES .....	4
5 DISCIPLINE PROGRAM BY TYPES OF CLASSES .....	5
6 KNOWLEDGE PROGRESS TESTING.....	6
6.1 Grading scales.....	6
6.2 Diagnostic tools and evaluation procedures .....	7
6.3 Evaluation criteria .....	8
7 TOOLS, EQUIPMENT, AND SOFTWARE .....	11
8 RECOMMENDED BIBLIOGRAPHY .....	11

## 1 DISCIPLINE OBJECTIVES

In the educational and professional programs of the Dnipro University of Technology specialty 192 Construction and Civil Engineering, the distribution of program learning outcomes (NRN) for the organizational forms of the educational process is done. In particular, the following learning outcomes are attributed to the discipline F13 “Strength of materials”:

<b>PH1</b>	Applying the basic theories, methods and principles of mathematical and natural sciences in the field of professional activity.
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**The Purpose of the Course** is the formation of competencies on basic concepts and principles during strength, rigidity, stability and endurance calculations of elements of structures considering their reliability and economy, promoting the development of logical and analytical thinking in students during construction of physical and mathematical models of elements or parts of structures, setting and solving construction problems.

The implementation of the objective requires transforming program learning outcomes into the disciplinary ones as well as an adequate selection of the contents of the discipline according to this criterion.

## 2 INTENDED DISCIPLINARY LEARNING OUTCOMES

Code NRN	Disciplinary learning outcomes (DRN)	
	DRN code	content
<b>PH1</b>	<b>PH1.1</b>	Knowing the problems of strength of materials, the main types of deformations and stresses.
	<b>PH1.2</b>	Being able to apply the method of cross-sections to determine the internal forces.
	<b>PH1.3</b>	Being able to construct diagrams of longitudinal forces, torques, transverse forces and bending moments.
	<b>PH1.4</b>	Perform strength, rigidity and stability calculations of structural elements and structures on a basis of laws of classical mechanics.

## 3 BASIC DISCIPLINES

Subjects	Acquired learning outcomes
B1 Higher Mathematics, F6 Engineering and Computer Graphics F15 Theoretical Mechanics	Applying the basic theories, methods and principles of mathematical and natural sciences in the field of professional activity.

## 4 WORKLOAD DISTRIBUTION BY THE FORM OF EDUCATIONAL PROCESS ORGANIZATION AND TYPES OF CLASSES

Type of classes	Workload hours	Distribution by forms of education, <i>hours</i>					
		Full-time		Part-time		Distance	
		Classes (C)	Individual work (IW)	Classes (C)	Individual work (IW)	Classes (C)	Individual work (IW)
lecture	90	30	60	-	-	10	80

practical	90	30	60	-	-	10	80
laboratory	-	-	-	-	-	-	-
workshops	-	-	-	-	-	-	-
TOGETHER	180	60	120	-	-	20	160

## 5 DISCIPLINE PROGRAM BY TYPES OF CLASSES

Ciphers	Types and topics of training sessions	Hours
	<b>LECTURES</b>	<b>90</b>
<b>PH1.1</b> <b>PH1.2</b> <b>PH1.3</b> <b>PH1.4</b>	<b>1. General provisions.</b>	10
	Problems of strength of materials.	
	Classification of external forces.	
	Hypotheses of material resistance.	
	Types of deformations.	10
	<b>2. Determination of internal force factors. Tension.</b>	
	Classification of internal forces.	
	Cross-section method. Stress.	
	Diagrams of longitudinal forces.	
	Torque diagrams.	
	Diagrams of transverse forces and bending moments.	12
	Differential dependencies for bending.	
	Diagrams of longitudinal, transverse forces and bending moments in frames.	
	<b>3. Elongation - compression.</b>	
	Deformation under elongation - compression.	
	Hooke's law.	
	Mechanical properties of materials. Elongation diagram.	10
	Permissible stresses. Strength calculations under elongation (compression).	
	Rigidity calculations under elongation (compression).	
	Consideration of the own weight of a rod. Maximum and critical rod length.	
	Statically indeterminate rod systems.	12
	<b>4. Shear.</b>	
	The concept of shear. Shear stress.	
	Shear deformations.	
	Shear strength calculations.	10
	Shear calculations of riveted and welded joints.	
	<b>5. Torsion (twisting).</b>	
Assumptions of the theory of torsion of round rods.		
Deformation and stresses during shaft rotation.	12	
Calculations for torsional strength and rigidity.		
<b>6. Geometric characteristics of plane sections.</b>	10	
Static moments.		
Axial, centrifugal and polar moments of inertia. Radius of inertia.		
Moments of inertia of the simplest figures.		
Transformation of moments of inertia at parallel transfer of axes.		
Transformation of moments of inertia for rotating axes. The main		

<b>Ciphers</b>	<b>Types and topics of training sessions</b>	<b>Hours</b>
	axes and moments of inertia.	
	<b>7. Bending.</b>	
	Basic concepts and definitions.	
	Stress during pure bending.	
	Stress during transverse bending.	
	Distribution of tangential stresses in a cross-section of a beam.	16
	Calculations of the bending strength of the beam.	
	Differential equation of the elastic axis of the beam.	
	Universal equation of the elastic line of the beam.	
	<b>8. Fundamentals of stress theory and strength theory.</b>	
	Stress in inclined cross-sections with axial elongation - compression	
	Types of stress states of the body.	
	Stress at a plane stress state. Main planes and the main stresses	10
	Generalized Hooke's law.	
	Potential energy of elastic deformation.	
	Theories (hypotheses) of strength.	
	<b>PRACTICAL CLASSES</b>	<b>90</b>
<b>PH1.1 PH1.2 PH1.3 PH1.4</b>	1. Diagrams of longitudinal forces. Torque diagrams	8
	2. Diagrams of transverse forces and bending moments.	8
	3. Calculations for tensile strength and rigidity (compression).	8
	4. Statically indeterminate systems in tension (compression).	8
	5. Determining the positions of the main planes and the main stresses.	8
	6. Calculations for shear strength.	8
	7. Calculations of torsional strength and rigidity.	8
	8. Determination of the main axes and main moments of inertia.	8
	9. Determination of stresses in pure and transverse bending	8
	10. Calculations of the bending strength of the beam.	10
	11. Universal equation of the elastic line of the beam.	8
	<b>PA3OM</b>	<b>180</b>

## 6 KNOWLEDGE PROGRESS TESTING

Certification of student achievement is accomplished through transparent procedures based on objective criteria in accordance with the University Regulations “On Evaluation of Higher Education Applicants' Learning Outcomes”.

The level of competencies achieved in relation to the expectations, identified during the control activities, reflects the real result of the student's study of the discipline.

### 6.1 Grading scales

Assessment of academic achievement of students of the Dnipro University of Technology is carried out based on a rating (100-point) and institutional grading scales. The latter is necessary (in the official absence of a national scale) to convert (transfer) grades for mobile students.

*The scales of assessment of learning outcomes of the DUT students*

<b>Rating</b>	<b>Institutional</b>
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90 ... 100	Excellent
74 ... 89	Good
60 ... 73	Satisfactory
0 ... 59	Failed

Discipline credits are scored if the student has a final grade of at least 60 points. A lower grade is considered to be an academic debt that is subject to liquidation in accordance with the Regulations on the Organization of the Educational Process of DUT.

## 6.2 Diagnostic tools and evaluation procedures

The content of diagnostic tools is aimed at controlling the level of knowledge, skills, communication, autonomy, and responsibility of the student according to the requirements of the National Qualifications Framework (NQF) up to the 7th qualification level during the demonstration of the learning outcomes regulated by the work program.

During the control activities, the student should perform tasks focused solely on the demonstration of disciplinary learning outcomes (Section 2).

Diagnostic tools provided to students at the control activities in the form of tasks for the intermediate and final knowledge progress testing are formed by specifying the initial data and a way of demonstrating disciplinary learning outcomes.

Diagnostic tools (control tasks) for the intermediate and final knowledge progress testing are approved by the appropriate department.

Type of diagnostic tools and procedures for evaluating the intermediate and final knowledge progress testing are given below.

### *Diagnostic and assessment procedures*

INTERMEDIATE CONTROL			FINAL ASSESSMENT	
training sessions	diagnostic tools	procedures	diagnostic tools	procedures
lectures	control tasks for each topic	task during lectures	comprehensive reference work (CCW)	determining the average results of intermediate controls;  CCW performance during the examination at the request of the student
practical	control tasks for each topic	tasks during practical classes		
	or individual task	tasks during independent work		

During the intermediate control, the lectures are evaluated by determining the quality of the performance of the control specific tasks. Practical classes are assessed by the quality of the control or individual task.

If the content of a particular type of teaching activity is subordinated to several descriptors, then the integral value of the assessment may be determined by the weighting coefficients set by the lecturer.

Provided that the level of results of the intermediate controls of all types of training at least 60 points, the final control can be carried out without the student's immediate participation by determining the weighted average value of the obtained grades.

Regardless of the results of the intermediate control, every student during the final knowledge progress testing has the right to perform the CDF, which contains tasks covering key disciplinary learning outcomes.

The number of specific tasks of the CDF should be consistent with the allotted time for completion. The number of CDF options should ensure that the task is individualized.

The value of the mark for the implementation of the CDF is determined by the average evaluation of the components (specific tasks) and is final.

The integral value of the CDF performance assessment can be determined by taking into account the weighting factors established by the department for each NLC descriptor.

### 6.3 Evaluation criteria

The actual student learning outcomes are identified and measured against what is expected during the control activities using criteria that describe the student's actions to demonstrate the achievement of the learning outcomes.

To evaluate the performance of the control tasks during the intermediate control of lectures and practicals the assimilation factor is used as a criterion, which automatically adapts the indicator to the rating scale:

$$O_i = 100 a / m,$$

where a - number of correct answers or significant operations performed according to the solution standard; m - the total number of questions or substantial operations of the standard.

Individual tasks and complex control works are expertly evaluated using criteria that characterize the ratio of competency requirements and evaluation indicators to a rating scale.

The content of the criteria is based on the competencies identified by the NLC for the Bachelor's level of higher education (given below).

*Table 1 - General criteria for achieving learning outcomes for the 7th qualification level for NQF (bachelor)*

descriptors NLC	Requirements for knowledge, communication, autonomy and responsibility	Indicator evaluation
<b>Knowledge</b>		
♦ Conceptual knowledge acquired during the training and professional activities,	- A great - proper, reasonable, sensible. Measures the presence of: - conceptual knowledge; - a high degree of state ownership issues; - critical understanding of the main theories, principles, methods and concepts in education and	95-100



descriptors NLC	Requirements for knowledge, communication, autonomy and responsibility	Indicator evaluation
including some knowledge of modern achievements; ♦ critical understanding of the main theories, principles, methods, and concepts in education and careers	careers	
	A non-gross contains mistakes or errors	90-94
	The answer is correct but has some inaccuracies	85-89
	A correct some inaccuracies but has also proved insufficient	80-84
	The answer is correct but has some inaccuracies, not reasonable and meaningful	74-79
	A fragmentary	70-73
	A student shows a fuzzy idea of the object of study	65-69
	Knowledge minimally satisfactory	60-64
Knowledge unsatisfactory	<60	
<b>Ability</b>		
♦ solving complex problems and unforeseen problems in specialized areas of professional and/or training, which involves the collection and interpretation of information (data), choice of methods and tools, the use of innovative approaches	- The answer describes the ability to: - identify the problem; - formulate hypotheses; - solve problems; - choose adequate methods and tools; - collect and interpret logical and understandable information; - use innovative approaches to solving the problem	95-100
	The answer describes the ability to apply knowledge in practice with no blunders	90-94
	The answer describes the ability to apply knowledge in practice but has some errors in the implementation of a requirement	85-89
	The answer describes the ability to apply knowledge in practice but has some errors in the implementation of the two requirements	80-84
	The answer describes the ability to apply knowledge in practice but has some errors in the implementation of the three requirements	74-79
	The answer describes the ability to apply knowledge in practice but has some errors in the implementation of the four requirements	70-73
	The answer describes the ability to apply knowledge in practice while performing tasks on the model	65-69
	A characterizes the ability to apply knowledge in performing tasks on the model, but with uncertainties	60-64
	The level of skills is poor	<60
<b>Communication</b>		
♦ report to specialists and non-specialists of information, ideas, problems, solutions and their experience in the field of professional activity; ♦ the ability to form an effective communication	- Fluent problematic area. Clarity response (report). Language - correct; - net; - clear; - accurate; - logic; - expressive; - concise. Communication strategy: coherent and consistent development of thought;	95-100

descriptors NLC	Requirements for knowledge, communication, autonomy and responsibility	Indicator evaluation
strategy	availability of own logical reasoning; relevant arguments and its compliance with the provisions defended; the correct structure of the response (report); correct answers to questions; appropriate equipment to answer questions; the ability to draw conclusions and formulate proposals	
	Adequate ownership industry issues with minor faults. Sufficient clarity response (report) with minor faults. Appropriate communication strategy with minor faults	90-94
	Good knowledge of the problems of the industry. Good clarity response (report) and relevant communication strategy (total three requirements are not implemented)	85-89
	Good knowledge of the problems of the industry. Good clarity response (report) and relevant communication strategy (a total of four requirements is not implemented)	80-84
	Good knowledge of the problems of the industry. Good clarity response (report) and relevant communication strategy (total not implemented the five requirements)	74-79
	Satisfactory ownership issues of the industry. Satisfactory clarity response (report) and relevant communication strategy (a total of seven requirements not implemented)	70-73
	Partial ownership issues of the industry. Satisfactory clarity response (report) and communication strategy of faults (total not implemented nine requirements)	65-69
	The fragmented ownership issues of the industry. Satisfactory clarity response (report) and communication strategy of faults (total not implemented 10 requirements)	60-64
	The level of poor communication	<60
<b>Autonomy and responsibility</b>		
<ul style="list-style-type: none"> <li>◆ management actions or complex projects, responsible for decision-making in unpredictable conditions;</li> <li>◆ responsible for the professional development of individuals and/or groups</li> <li>◆ the ability to continue study with a high degree of autonomy</li> </ul>	<ul style="list-style-type: none"> <li>- Excellent individual ownership management competencies focused on:               <ol style="list-style-type: none"> <li>1) management of complex projects, providing:                   <ul style="list-style-type: none"> <li>- exploratory learning activities marked the ability to independently evaluate various life situations, events, facts, detect and defend a personal position;</li> <li>- the ability to work in a team;</li> <li>- control of their own actions;</li> </ul> </li> <li>2) responsibility for decision-making in unpredictable conditions, including:                   <ul style="list-style-type: none"> <li>- justify their decisions the provisions of the regulatory framework of sectoral and national levels;</li> <li>- independence while performing tasks;</li> <li>- lead in discussing problems;</li> <li>- responsibility for the relationship;</li> </ul> </li> <li>3) responsible for the professional development of individuals and/or groups that includes:                   <ul style="list-style-type: none"> <li>- use of vocational-oriented skills;</li> <li>- the use of evidence from independent and correct reasoning;</li> </ul> </li> </ol> </li> </ul>	95-100

descriptors NLC	Requirements for knowledge, communication, autonomy and responsibility	Indicator evaluation
	- possession of all kinds of learning activities; 4) the ability to further study with a high degree of autonomy, which provides: - degree possession of fundamental knowledge; - independent evaluation judgments; - high level of formation of general educational skills; - search and analysis of information resources	
	Confident personality possession competency management (not implemented two requirements)	90-94
	Good knowledge management competencies personality (not implemented three requirements)	85-89
	Good knowledge management competencies personality (not implemented the four requirements)	80-84
	Good knowledge management competencies personality (not implemented six requirements)	74-79
	Satisfactory ownership of individual competence management (not implemented seven requirements)	70-73
	Satisfactory ownership of individual competence management (not implemented eight claims)	65-69
	The level of autonomy and responsibility fragmented	60-64
	The level of autonomy and responsibility poor	<60

## 7 TOOLS, EQUIPMENT, AND SOFTWARE

Technical training tools via multimedia software.

Distance learning platform Moodle and MS Teams.

## 8 RECOMMENDED BIBLIOGRAPHY

1. [Strength of Materials. Textbook. Illustrative Material](#) / A.M. Dolgov. - D.: National Mining University, 2015. - 68 p.
2. [Strength of Materials](#) / N.M. Belyaev. – M.: Mir Publishers, 1979. – 648 p.
3. Писаренко Г.С. Strength of Materials: Textbook / Г.С. Писаренко, О.Л. Квітка, Е.С. Уманський; За ред. Г.С. Писаренка. – 2-ге вид., допов. і переробл. – К.: Вища шк., 2004. – 655 С. [in Ukrainian]
4. Александров А.В. Strength of Materials: Textbook for Universities/ А.В. Александров, В.Д. Потапов, Б.П. Державин; Под ред. Александрова А.В. – 3-е изд. испр. – М.: Выш. шк., 2003. – 560 с. [in Russian]
5. Степин П.А. Strength of Materials: Учеб. для немашиностроит. спец. вузов. – 9-е испр. – М.: Интеграл-Пресс, 1997. – 320 с. [in Russian]

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