Ministry of Education and Science of Ukraine Dnipro University of Technology

Department of Mechanical and Biomedical Engineering



«APPROVED» Head of Department Kolosov D.L . _________ 31.08.2022

WORK PROGRAM OF THE ACADEMIC DISCIPLINE

«Technical Mechanics»

14 Electrical engineering
141 Electrical energetics, electrical
engineering and electromechanics
first (bachelor)
«Electrical energetics, electrical engineering and electromechanics»
-
normative
4 credits ECTS (120 hours)
exam
4 semester (7, 8 terms)
English

Lecturer: Prof. Dolgov O.M.

Prolonged: for 20_/20_ acad. year. _____(____) «__»___20__. for 20_/20_ acad. year. _____(____) «__»___20__.

> Dnipro DNIPROTECH 2022

Work program of the academic discipline «Technical Mechanics» for bachelors of the educational and professional program «Electrical energetics, electrical engineering and electromechanics» of the specialty 141 Electrical energetics, electrical engineering and electromechanics / Dnipro University of Technology, Department of Mechanical and Biomedical Engineering. – D.: DNIPROTECH, 2022 – 13 p.

Author:

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The work program regulates:

- the aim of the discipline;
- the disciplinary learning outcomes generated through the transformation of the intended learning outcomes of the degree program;
- basic disciplines;
- volume and distribution by forms of organization of the educational process and types of classes;
- discipline program (thematic plan by type of training);
- algorithm for assessing the level of achievement of disciplinary learning outcomes (scales, tools, procedures and assessment criteria);
- tools, equipment and software;
- recommended sources of information.

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 Scientific and Methodological Commission of the specialty 141 Electrical energetics, electrical engineering and electromechanics (protocol №21/22-07 of 14.07.2022).

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1 AIM OF THE DISCIPLINE

In the educational and professional program «Electrical energetics, electrical engineering and electromechanics» of the specialty 141 Electrical energetics, electrical engineering and electromechanics the distribution of program learning outcomes (PLO) for the organizational forms of the educational process is done. In particular, the following learning outcome is attributed to the discipline $\Phi 6$ «Technical Mechanics»:

ΠΡ07 To carry out the analysis of processes in the electric power, electrotechnical and electromechanical equipment, the corresponding complexes and systems.

The aim of the discipline is to form knowledge of general methods of using the basic laws and principles of mechanics necessary for the analysis of physical phenomena, modeling of various processes and finding optimal solutions to problems arising in the development, technical implementation and operation of electromechanical and electric power equipment.

The implementation of the aim 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.

Code	Code	Disciplinary learning outcomes (DLO)				
PLO	DLO	content				
ПР07	ПР07.1-Ф6	compose and resolve equilibrium equations for systems of forces, determine force factors and build their diagrams				
	ПР07.2-Ф6	compose and solve the equation of motion of material bodies				
	ПР07.3-Ф6	find the kinematic characteristics of the motion of solids				
	ПР07.4-Ф6	6 use general theorems and principles of dynamics for analysis, mechani processes in machines and devices of electromechanical equipment				
	ПР07.5-Ф6	perform engineering calculations for strength, rigidity and stability in tension, compression, torsion and bending				
	ΠΡ07.6-Φ6 apply the acquired knowledge for diagnostics and modeling of structures of machinery and mechanisms of electromechanical equipment.					

2 INTENDED DISCIPLINARY LEARNING OUTCOMES

3 BASIC DISCIPLINES

Course title	Achieved learning outcomes
Б1 «Higher Mathematics»	 PLO07.1-51 Know the basics and principles of linear and vector algebra, analytical geometry, differential and integral calculus. PLO07.2-51 Be able to use a mathematical apparatus for objective analysis of processes in electromechanical equipment. PLO08.1-51 Know the principles of solving technical problems based on mathematical analysis, construction and solution of differential equations.

Б2 «General physics»	PLO07.1-52 Analyze the results of observations and
	experiments using the basic laws of physics, use physical
	devices.
	PLO07.2-52 To analyze physical mechanisms that are
	essential when considering processes in electric power,
	electrotechnical and electromechanical equipment, relevant
	complexes and systems.
	PLO07.3-52 Formation of abilities to generalize, analyze,
	perceive information, set a scientific problem and choose a
	way to solve it.
	PLO08.1-52 Formulate physical ideas, solve problems,
	estimate quantities, operate physical models and be aware of
	the limits of their applications
БЗ «Computing and	PLO06 To apply application software, microcontrollers and
programming»	microprocessor technology to solve practical problems in
	professional activities.

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

	ad	Distribution by forms of education , hours					
Type of	klo s	Full	-time	Part	t-time	Extr	amural
classes	/or	Classes	Individual	Classes	Individual	Classes	Individual
	W	(C)	work (IW)	(C)	work (IW)	(C)	work (IW)
lectures	60	34	26	-	-	6	54
practical	60	25	35	-	-	6	54
laboratory	-	-	-	-	-	-	_
TOTAL	120	59	61	_	-	12	108

5 DISCIPLINE PROGRAM BY TYPES OF CLASSES

Code		Volume of	
	Types and topics of classes		
DLO		hours	
	Lectures	60	
ПР07.1-Ф6	1. Basic concepts and axioms of statics	2	
	1.1. Subject of statics. Basic concepts and axioms		
	1.2. Constraints, their classification		
	1.3. Moment of a force relative to the pole and axis		
ПР07.1-Ф6	2. Equilibrium conditions of force systems	6	
	2.1. Equivalent systems of forces		
	2.2. Reduction of an arbitrary system of forces to the simplest form		
	2.3. Center of parallel forces. Center of gravity. Methods of finding		
	the center of gravity		
	2.4. Equilibrium conditions of particular cases of force systems		
ПР07.2-Ф6	3. Kinematics of the point	2	
ПР07.3-Ф6	3.1. The subject of kinematics. Space and time in classical		
	mechanics		
	3.2. Determining the motion of a point, path		
	3.3. Determining velocity and acceleration of a point		

ПР07.2-Ф6	4. The simplest movements of a rigid body	2
ПР07.3-Ф6	4.1. Translational motion of a rigid body	_
	4.2. Rotation of a rigid body around a fixed axis. Angular velocity	
	and angular acceleration of the body	
	4.3. Velocity and acceleration of points of a rotating solid	
	5. Plane motion of a rigid body	6
	5.1. Equation of plane motion. Distribution of velocities of points of	
	a plane figure. Velocity projection theorem	
	5.2. Determining velocities and accelerations of body points in	
	plane motion	
	5.3. Instantaneous center of velocities and ways to find it. ICV as a	
	pole. Methods for determining the angular velocity and angular	
	acceleration of a plane figure	
ПР07.4-Ф6	6. Dynamics of the point	4
	6.1. The subject of dynamics. Laws of dynamics	
	6.2. Problems of point dynamics	
	6.3. Differential equations of the motion of a point	
ПР07.4-Ф6	7. General theorems of dynamics	8
ПР07.5-Ф6	7.1. The concept of mechanical systems. Mass and geometric	
	characteristics of systems and solids	
	7.2. Measures of mechanical motion of the system	
	7.3. Measures of mechanical interaction	
	7.4. Theorem of the center of mass motion of a mechanical system.	
	The law of motion of the center of mass of the material system	
	7.5. Theorem of the change in the momentum and kinetic	
	momentum of mechanical system. Equation of motion of a rigid	
	body around a fixed axis 7.6 Theorem of the characteristic energy	
	7.6. Theorem of the change in of kinetic energy	
ПР07.4-Ф6	8. Fundamentals of the theory of oscillations	6
ПР07.5-Ф6	8.1. Types of point oscillations. Differential equations of point	
	oscillations	
	8.2. Free oscillations	
	8.3. Forced oscillations Decrement oscillations. Resonance	
ПР07.4-Ф6	9. Introduction to Strength of Materials	2
ПР07.5-Ф6	9.1. Basic hypotheses. Types of beam deformation	
	9.2. Stress and strain	
ПР07.4-Ф6	10. Axial tension and compression	6
ПР07.5-Ф6	10.1 Deformation of tension and compression. Longitudinal forces	
	and drawing their diagrams	
	10.2. Tension. Longitudinal and transverse deformations. Hooke's	
	law	
	10.3. Mechanical characteristics of materials. Tension and	
	compression diagrams. Dangerous stresses. Strength and working	
	stress. Strength condition	
ПР07.4-Ф6	11. Torsion	4
ПР07.5-Ф6	11.1. Determining torques and drawing their diagrams	
	11.2. Stress and strain at torsion of round cross section rods	
	11.3. Calculation of strength and rigidity	

ПР07.4-Ф6	12. Straight transverse bending	6
ПР07.5-Ф6	12.1. Types of bent beams. Internal efforts at direct	
	transverse bending and drawing their diagrams	
	12.2. Differential dependences at bending. Differential equation of	
	the elastic line of the beam	
	12.3. Normal stress at pure bending. Calculation of beams on	
	strength by normal stresses	
<u>ПР07</u> 4-Ф6	13 Basics of machine parts	6
$\Pi 07.4-\Phi 0$ $\Pi P07.6-\Phi 6$	13.1 Belt and chain transmissions	0
11107.0-40	13.2. Georg and worm georg	
	13.2. Ocals and worm gears	
	12.4 December 2	
	12.5. Detachable and non-detachable connections	
	13.5. Detachable and non-detachable connections	
	15.0. Couplings	60
ΠD071 Φ6	Fractical Classes	2
$\frac{\Pi P07.1-\Psi 0}{\Pi P07.1-\Phi 6}$	Equilibrium of concurrent force system	<u> </u>
$\Pi P07.1-\Psi 0$	Equilibrium of coplanar force system	4
$\frac{\Pi F07.2-\Phi0}{\Pi P07.2-\Phi6}$	Point kinematics: determining noth velocity and acceleration of a	2
ΠΓ07.3-Φ0	point kinematics, determining path, velocity and acceleration of a	5
ПР07 3-Ф6	Rotational motion of a rigid body around a fixed axis. Determining	3
11107.5-40	the speed and acceleration of the body points	5
ПР07 3-Ф6	Plane motion of a rigid body determining velocities and	6
11107.5-40	acceleration points of the body	0
ΠΡ07.4 Φ6	Solution of the first and second problems of point dynamics	1
$\Pi 07.4-\Phi 0$ $\Pi P 07.4 \Phi 6$	Using the theorem of the center of mass motion of a mechanical	
11107.4-90	system	5
ПР07.4-Ф6	Using the kinetic moment theorem of a point and a system	3
ПР07 4-Ф6	Using the theorem of the change in kinetic energy of a point and a	6
111 0 / 11 4 0	system	Ũ
ПР07.4-Ф6	Oscillatory motion of a material point: free, damping and forced	3
	oscillations	-
ПР07.5-Ф6	Calculation of tensile and compressive strength and rigidity	4
ПР07.5-Ф6	Calculations for torsional strength and rigidity	4
ПР07.5-Ф6	Diagrams of internal efforts for beams at bending	4
ПР07.5-Ф6	Calculations for the strength of transverse bending by normal stress	3
ПР07.5-Ф6	Fundamentals of calculation of mechanical gears	4
ПР07.6-Ф6	Shaft calculation and bearing selection	3
	TOTAL	120

For the implementation of the mixed form of education of students, the electronic resources of the e-learning platform in the discipline are used: https://do.nmu.org.ua/enrol/index.php?id=2425

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.

Rating	Institutional
90 100	відмінно / Excellent
74 89	добре / Good
60 73	задовільно / Satisfactory
0 59	незадовільно / Fail

The scales of assessment of learning outcomes of the DNIPROTECH students

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 DNIPROTECH.

6.2 Tools and procedures

The content of diagnostic tools is aimed at controlling the level of knowledge, proficiency/skills, communication, autonomy, and responsibility of the student according to the requirements of the National Qualifications Framework (NQF) up to the 6th 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 formative and summative knowledge progress testing are formed by specifying the initial data and a way of demonstrating disciplinary learning outcomes.

Diagnostic tools (control tasks) for the formative and summative knowledge progress testing are approved by the department.

Types of diagnostic tools and procedures for evaluating the formative and summative knowledge progress testing are given below.

FORMATIVE ASSESSMENT			SUMMATIVE ASSESSMENT		
training session	diagnostic tools	procedures	diagnostic tools	procedures	
lectures	control tasks for each topic	poll	comprehensive control work	determining the average results of formative	
practical	control tasks for each topic	performing tasks during practical classes	(CCW)	assessments; CCW performance during	

Diagnostic and assessment procedures

	individual task	performing tasks during individual	the examination at the request of the student
		work	

During the formative assessment, 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 and individual task.

If the content of a certain type of classes is subordinated to several components of the description of the qualification level according to the NQF, the integral value of the grade can be determined taking into account the weighting coefficients set by the lecturer.

Provided that the level of results of the formative assessments of all types of training at least 60 points, the summative assessment 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 formative assessments, every student during the summative knowledge progress testing has the right to perform the CCW, which contains tasks covering key disciplinary learning outcomes.

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

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

The integral value of the assessment of the implementation of the CCW can be determined taking into account the weighting coefficients established by the department for each component of the description of the qualification level of the NQF.

6.3 Criteria

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

To assess the performance of control tasks during the formative assessment on lectures and practical classes the coefficient of mastery is used as a criterion, which automatically adapts the assessment indicator to the rating scale:

$$O_i = 100 \ a/m,$$

where a is a number of correct answers or significant operations performed in accordance with the solution standard; m is the total number of questions or significant operations of the standard.

Individual tasks and complex control works are assessed expertly using criteria that characterize the ratio of requirements to the level of competencies and indicators of assessment on a rating scale.

The content of the criteria is based on the competency characteristics defined by the NQF for the bachelor's level of higher education (given below).

		т 1. (
Description of	Requirements for knowledge, proficiency/skills,	Indicator
qualification level	communication, autonomy and responsibility	evaluation
	Knowleges	
Conceptual scientific and practical knowledge, critical understanding of theories, principles, methods and concepts in the field of	The answer is excellent - correct, reasonable, meaningful. Characterizes the presence of: - conceptual knowledge; - high degree of knowledge of the state of the art; - critical understanding of the basic theories, principles, methods and concepts in education and professional activity	95-100
and / or training	The answer contains innot criors of oninssions	90-94 85.80
and / or training	The answer is correct, but has some inaccuracies and is insufficiently substantiated	80-84
	The answer is correct, but has some inaccuracies, insufficiently substantiated and meaningful	74-79
	The answer is fragmentary	70-73
	The answer shows the student's vague ideas about the object of study	65-69
	The level of knowledge is minimally satisfactory	60-64
	The level of knowledge is unsatisfactory	<60
	Proficiency/Skills	•
In-depth cognitive and practical skills, mastery and innovation at the level required to solve complex specialized tasks and practical problems in the field of	The answer characterizes the ability to: - identify problems; - formulate hypotheses; - solve problems; - choose appropriate methods and tools; - collect and interpret information logically and clearly; - use innovative approaches to solving problems	95-100
professional activity or training	The answer characterizes the ability to apply knowledge in practice with minor errors	90-94
uannig	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of one requirement	85-89
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the two requirements	80-84
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the three requirements	74-79
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the four requirements	70-73
	The answer characterizes the ability to apply knowledge in practice when performing tasks on the model	65-69
	The answer characterizes the ability to apply knowledge in	60-64

General criteria for achieving learning outcomes

for the 6th aualification level of NOF (bachelor)

Description of	Requirements for knowledge, proficiency/skills,	Indicator
qualification level	communication, autonomy and responsibility	evaluation
	performing tasks on the model, but with inaccuracies	
	The level of skills is unsatisfactory	<60
	Communication	
 reporting to 	Fluency in industry issues.	95-100
specialists and non-	Clarity of the answer (report). Language:	
specialists	- correct;	
information, ideas,	- clean;	
problems, solutions,	- clear;	
own experience and	- accurate;	
argumentation	- logical;	
 data collection, 	- expressive;	
interpretation and	- concise.	
application	Communication strategy:	
 communication on 	- consistent and consistent development of thought;	
professional issues,	- the presence of logical own judgments;	
including in a foreign	- appropriate reasoning and its compliance with the	
language, orally and	defended provisions;	
in writing	- correct structure of the answer (report);	
	- correct answers to questions;	
	- appropriate technique for answering questions;	
	- ability to draw conclusions and formulate proposals;	
	Sufficient knowledge of industry issues with minor flaws.	90-94
	Sufficient clarity of the answer (report) with minor flaws.	
	Relevant communication strategy with minor flaws.	
	Good knowledge of industry issues.	85-89
	Good clarity of the answer (report) and appropriate	
	communication strategy (three requirements in total are not	
		00.04
	Good knowledge of industry issues.	80-84
	Good clarity of the answer (report) and appropriate	
	communication strategy (four requirements not	
	Cood knowledge of industry issues	74 70
	Good knowledge of industry issues.	/4-/9
	communication strategy (five requirements not	
	implemented in total)	
	Satisfactory knowledge of industry issues	70-73
	Satisfactory clarity of the answer (report) and appropriate	10-13
	communication strategy (a total of seven requirements have	
	not been implemented)	
	Partial knowledge of industry issues	65-69
	Satisfactory clarity of the answer (report) and	05 07
	communication strategy with errors (a total of nine	
	requirements are not implemented)	
	Partial knowledge of industry issues.	60-64
	Satisfactory clarity of the answer (report) and	
	communication strategy with errors (a total of 10	
	requirements are not implemented)	
	The level of communication is unsatisfactory	<60
	Autonomy and responsibility	

Description of	Requirements for knowledge, proficiency/skills,	Indicator
qualification level	communication, autonomy and responsibility	evaluation
• managing complex	Excellent command of personal management competencies	95-100
technical or	focused on:	
professional activities	1) management of complex projects, which involves:	
or projects	- research nature of educational activities, marked by the	
• ability to take	ability to independently assess various life situations,	
responsibility for	phenomena, facts, identify and defend a personal position;	
making and making	- ability to work in a team;	
decisions in	- control of own actions;	
unpredictable work	2) responsibility for decision-making in unpredictable	
and / or learning	conditions, including:	
contexts	- justification of own decisions by the provisions of the	
 formation of 	regulatory framework of the industry and state levels;	
judgments that take	- independence in the performance of tasks;	
into account social,	- initiative in discussing problems;	
scientific and ethical	- responsibility for relationships;	
aspects	3) responsibility for the professional development of	
 organization and 	individuals and/or groups of individuals, which involves	
management of	- use of professionally oriented skills;	
professional	- use of evidence with independent and correct	
development of	argumentation;	
individuals and groups	- mastery of all types of learning activities;	
 ability to continue 	4) the ability to continue learning with a high level of	
studies with a	autonomy, which includes	
significant degree of	- the degree of mastery of fundamental knowledge;	
autonomy	- independence of evaluative judgments;	
	- a high level of general learning skills;	
	independent search and analysis of information sources	
	Good mastery of personality management competencies	90-94
	(two requirements not met)	
	Good mastery of personality management competencies	85-89
	(three requirements not met)	
	Good mastery of personality management competencies	80-84
	(four requirements not met)	
	Good mastery of personality management competencies	74-79
	(six requirements not met)	
	Satisfactory mastery of personality management	70-73
	competencies (seven requirements not met)	
	Satisfactory mastery of personality management	65-69
	competencies (eight requirements not met)	
	The level of responsibility and autonomy is fragmentary	60-64
	The level of autonomy and responsibility is unsatisfactory	<60

7 TOOLS, EQUIPMENT AND SOFTWARE

Technical teaching aids (laboratory equipment, personal computers, multimedia equipment).

Remote platform (Teams, Zoom).

8 RECOMMENDED SOURCES OF INFORMATION

1. S. Targ. Theoretical Mechanics. A Short Course. – Moscow: Foreign Languages Publishing House, 1974. – 421 p.

2. N.M. Belyaev. Strength of Materials. – Moscow: Mir Publisher, 1979. –647 p.

3. Theoretical mechanics. Kinematics [Text]: Summary of lectures/ A.M.Dolgov. - D.: National Mining institute, 1992. - 39 p.

4. Elements of Strength of Materials. [Text]: Summary of lectures, Part 1/ Blokhin S.E., A.M. Dolgov. - D.: National Mining university, 1998. - 35 p.

5. Theoretical Mechanics. Statics [Text]: Summary of lectures/ A.M.Dolgov. - D.: National Mining university, 1998. - 37 p.

6. Theoretical Mechanics. Dynamics [Text]: Summary of lectures/ A.M.Dolgov. - D.: National Mining university, 2000. - 49 p.

7. Theoretical Mechanics. Dynamics [Text]: tutorial/ O.M.Dolgov. - D.: National Mining university, 2012. - 160 p.

8. Dolgov, A.M. Theoretical mechanics [electronic resource] : electronic textbook / O.M.Dolgov ; Ministry of Education and Science of Ukraine, National Mining

University. – Dnipropetrovs'k : NMU, 2015. – 124 p.

9. O.M. Dolgov, D.L.Kolosov. Mechanics of Machines [Text]: Study Guide / A.M. Dolgov. – D.: NTU «Dnipro university of technology», 2020. – 64 p.

Information Resources:

https://do.nmu.org.ua/course/view.php?id=2592

https://do.nmu.org.ua/course/view.php?id=2425

https://do.nmu.org.ua/course/view.php?id=2070

https://btpm.nmu.org.ua/ua/vydav/metodichka.php

https://btpm.nmu.org.ua/ua/selfstudy/och.php

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«Technical Mechanics» for bachelors of the educational and professional program «Electrical energetics, electrical engineering and electromechanics» of the specialty 141 Electrical energetics, electrical engineering and electromechanics

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> > Editorial by the author

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