

Ministry of Education and Science of Ukraine
Sumy National Agrarian University
Engineering and Technological Faculty
Department of Technical Systems Design

Course Syllabus

EC 9 Theoretical Mechanics (compulsory)

Implemented within the Agricultural Engineering educational programme
under specialty H7 “Agricultural Engineering”

at the first (Bachelor’s) level of higher education

Розробники:



Олександр ІВЧЕНКО, канд. техн.
наук, доц., зав. каф. ПТС

Розглянуто, схвалено та затверджено на засіданні кафедри проектування технічних систем	Протокол № 14 від «03» червня 2026 р.	
	Завідувач кафедри	 (підпис) Олександр ІВЧЕНКО (Ім'я та ПРІЗВИЩЕ)

Погоджено:

Гарант освітньої програми



Богдан САРЖАНОВ

Декан ІТФ



Рецензія на робочу програму
(додається) надана:



Богдан САРЖАНОВ

Методист відділу якості освіти,
ліцензування та акредитації



Михайло ДУМАНЧУК



Богдан САРЖАНОВ

Зареєстровано в електронній базі:

24 серпня 2026 р.

Information on reviewing the work program (syllabus):

Academic year in which changes are introduced	Appendix number to the Course Syllabus describing the changes	Changes reviewed and approved		
		Date and number of the minutes of the Department meeting	Head of the Department	Educational Programme Guarantor

1. GENERAL INFORMATION ПРО ОСВІТНІЙ КОМПОНЕНТ

1.	Name EC	Theoretical Mechanics							
2.	Faculty / department	Engineering and Technological / Technical Systems Design							
3.	Status EC	Compulsory							
4.	Program / Specialty (programs), which is a component of EC for (to be filled in for mandatory EC)	Educational Programme: “Agricultural Engineering” / H7 Agricultural Engineering							
5.	The EC may be offered for (to be filled in for selective EC)								
6.	NRC level	Level 6							
7.	Semester and duration of study	Full-time study: <i>First year:</i> Semester 1 – 18 weeks							
8.	Number of ECTS credits	5							
9.	Total hours and their distribution: Year 1 Semester 1 – 150 hours, examination	Contact hours (classes)						Independent study	
		Lectures		Practical / seminar		Laboratory			
		Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
		30	-	-	-	30	-	90	-
10.	Language of instruction	Ukrainian / English							
11.	Teacher/Educational Component Coordinator	Ivchenko Oleksandr, PhD in Technical Sciences, Head of the Department of Technical Systems Design Consultation hours – every Monday from 10:00 to 12:00, room 415m							
11.1	Contact information	oleksandr.ivchenko@snau.edu.ua							
12.	General description of the educational component	This educational component is a natural science that addresses the most general laws of the mechanical motion and equilibrium of material objects and applies mathematical methods, formal logic, similarity methods, etc. in its theorems. It develops in future specialists an understanding of the principles, methods and laws of theoretical mechanics that correctly reflect the objective realities of mechanical processes, the interrelationships of mechanical motions and energy transformation, and enables them to scientifically predict patterns in new problems and situations. As a result, future specialists will be able to design and assess the suitability of structures for load-bearing capacity and strength reserves both at the design stage and during the modernization of existing structures.							
13.	Purpose of the educational component	The aim of the course is to acquire theoretical and practical knowledge, skills and other competences for successful professional activity; the use of modern materials and components; the design and modernization of structures, individual structural elements and							

		their engineering networks; and the installation and construction of structures and facilities based on modern technological solutions.
14.	Prerequisites for studying EC, connection with other educational components of EP	The educational component is based on: EC 6 Higher Mathematics and Physics; 2. The educational component provides a basis for: EC 14 Tractors and Automobiles; EC 15 Agricultural Machinery; EC 24 Operation of machines and equipment; EC 25 Technical Service and Repair of Machines; EC 27 Feasibility Study of Agricultural Production Processes; EC 29 Preparation and Defence of the Qualification Thesis
15.	Academic Integrity Policy	The requirements imposed on a higher education student while studying the educational component are: – students must complete assessment stages within the established deadlines; – written and practical assignments must be completed and defended within the established deadlines; – compliance, when completing written assignments, with the SNAU Regulation on Prevention and Detection of Academic Plagiarism (https://bit.ly/2TNvfE0); – students must comply with the SNAU Academic Integrity Code (https://bit.ly/3xf92wW). Written assignments submitted for assessment must be original and completed independently by the higher education student. Written assignments completed and submitted late without valid reasons are graded one grade lower than the result achieved. Assignments with a low level of originality or copied from another person's work are awarded zero points, followed by completion of another original individual assignment. Resubmission of written assignments is permitted after they have been redone or revised. Copying from various sources of information (including using mobile devices and gadgets) during examinations is prohibited. If copying is detected, the student's work is cancelled and the examination must be retaken. Retaking the assessment is permitted by the Postgraduate and Doctoral Studies Office within the specified deadlines after the student has repeated the educational component material.
16.	Link to the course in Moodle	https://cdn.snau.edu.ua/moodle/course/view.php?id=6091
17.	Keywords	Mechanism, force, moment, couple of forces, vector, system of equations, body motion, kinematics, statics, dynamics.

2. РЕЗУЛЬТАТИ НАВЧАННЯ ЗА ОСВІТНІМ КОМПОНЕНТОМ ТА ЇХ ЗВ'ЯЗОК З ПРОГРАМНИМИ РЕЗУЛЬТАТАМИ НАВЧАННЯ

Learning outcomes for the EC: After completing the educational component, the student is expected to be able to...»	Program learning outcomes to which the EC contributes (indicate the number according to the numbering in the educational program)			How the learning outcome is assessed
	ILO 7	ILO 13	ILO 16	
CLO 1. Determine quantitative indicators of support and constraint reactions when calculating beams, trusses and other structural and mechanical elements and their components.	x			Execution and submission of completed laboratory work for verification, protection of laboratory work by testing with multiple choice tests.
CLO 2. Design engineering structures and their elements taking into account engineering and resource-saving measures, social, environmental and technical-economic indicators, scientific and aesthetic aspects, current requirements of regulatory documentation, time and other constraints.	x			
CLO 3. Understand the motion of machine elements and its main quantitative parameters. Be able to calculate these parameters and understand the operating principles of machines.		x		
CLO 4. Be able to perform expert analysis of the load-bearing capacity of existing structures and elements during their operation and modernization.			x	

3. CONTENT OF THE EDUCATIONAL COMPONENT (COURSE PROGRAMME)

Topic List of questions to be considered within the topic	Distribution within the total time budget						Recom- mended reading
	Contact work				Independent study		
	Full-time		Part-timea		Full- time	Part- timea	
	Lec- tures	Labo- ratory	Lec- tures	Labo- - rator y			
Part 1 (Semester 1)							
Topic 1. General concepts of statics. Subject of statics. Force. Axioms of statics. Mechanical constraints and their reactions.	2	2	-	-	4	-	[1], [3], [4]
Topic 2. Concurrent force system. Resultant of a concurrent force system. Projection of a force onto an axis and a plane. Analytical method for determining the resultant. Geometric condition for a concurrent force system. The theorem of three non-parallel forces. Analytical equilibrium conditions. Statically determinate and statically indeterminate problems. Methods and examples for solving statics problems.	2	2	-	-	4	-	[1], [3], [4], [5], [6], [7]
Topic 3. Moment of a force. Moment of a force about a centre (point). Varignon’s theorem for a system of concurrent forces. Moment equations for a planar system of concurrent forces. Moment of a force about an axis. Relationship between the moment of a force about a point and about an axis passing through that point. Moment of a force about coordinate axes.	2	2	-	-	4	-	[1], [3], [4], [5], [6], [7]
Topic 4. Theory of couples of forces. Addition of two parallel forces. Couple of forces. Moment of a couple. Equivalence of couples. Addition of couples. Equilibrium conditions for couples.	2	2	-	-	6	-	[1], [3], [4], [5], [6], [7]
Topic 5. Analysis of flat trusses. Basic concepts of planar trusses. Method of joints. Ritter’s method.	2	2	-	-	4	-	[1], [2], [3], [5], [6], [7]
Topic 6. Reduction of an arbitrary force system to a given centre. Lemma on parallel transfer of forces. Reduction of an arbitrary system of forces. Principal vector and principal moment of the system. Vector equilibrium conditions of an arbitrary system of forces. Analytical definition of the principal vector and principal moment of an arbitrary spatial system of forces. Analytical equilibrium conditions of an arbitrary spatial system of forces. Analytical equilibrium conditions of a spatial system of parallel forces. Invariants of reduction of an arbitrary spatial system of forces. Partial cases of reduction of an arbitrary spatial system of forces.	2	-	-	-	4	-	[1], [2], [3], [4], [5], [6], [7]
Topic 7. System of forces arbitrarily located in a plane (arbitrary planar force system).	2	4	-	-	4	-	[1], [2], [3], [4],

Determination of the principal vector and principal moment of an arbitrary planar force system. Reduction of an arbitrary planar force system. Analytical equilibrium conditions for an arbitrary planar force system. Equilibrium of a planar system of parallel forces. Distributed loads. Equilibrium of a system of bodies.							[5], [6], [7]
Topic 8. Friction. Sliding friction. Coulomb's laws. Angle and cone of friction. Rolling friction. Friction in rotation.	2	2	-	-	8	-	[1], [2], [3], [4], [7]
Topic 9. Body center of gravity. Coordinates of the centre of parallel forces. Centre of gravity of a rigid body. Centre of gravity of a homogeneous body. Methods for determining the centre of gravity.	2	2	-	-	8	-	[1], [2], [3], [4], [5], [6], [7]
Topic 10. Kinematics of a point. Equation of motion of a point. Velocity of a point. Acceleration of a point. Uniform and uniformly variable motion of a point.	2	2	-	-	8	-	[1], [2], [3], [4], [5], [6], [7]
Topic 11. Basic types of rigid body motion. Number of degrees of freedom and equation of motion of a rigid body. Translational motion of a rigid body. Rotational motion of a body about a fixed axis. Transmission mechanisms.	2	2	-	-	8	-	[1], [2], [3], [4], [5], [6], [7]
Topic 12. Kinematics of complex point motion. Definition of the parameters of complex motion. Calculation of velocities and accelerations in complex motion. Theorems of addition of velocities and accelerations.	2	2	-	-	8	-	[1], [2], [3], [4], [5], [6], [7], [8]
Topic 13. Plane-parallel (planar) motion of a rigid body. Planar motion of a body and motion of a plane figure. Equations of motion of a plane figure. The theorem of the velocity of a point of a plane figure. The theorem of projections of the velocities of two points of a body. Instantaneous centre of velocities. Determination of point velocities using the instantaneous centre of velocities. Velocity diagram. Acceleration of a point of a plane figure. Instantaneous centre of accelerations. Determination of accelerations of points of a plane figure using the instantaneous centre of accelerations.	2	2	-	-	8	-	[1], [2], [3], [4], [5], [6], [7], [8]
Topic 14. Complex motion of a rigid body. Addition of two rotational motions of a body about parallel axes. Analysis of planetary and differential mechanisms, Willis' formula. Addition of rotational motions of a body about intersecting axes. Equations of spherical motion of a rigid body. Euler angles. Determination of angular velocity and angular acceleration of a body from its equations of motion. Analytical determination of point velocities during spherical motion using the method of instantaneous axes. Euler-d'Alembert theorem. Motion of a free rigid body. Equations of motion. Velocities of points of a free rigid body. Accelerations of points of a free rigid body.	4	2	-	-	12	-	[1], [2], [3], [4], [5], [6], [7]
Total	30	30	-	-	90	-	

4. TEACHING AND LEARNING METHODS

CLO	Teaching methods (activities performed by the lecturer during classes and consultations)	Number of hours	Learning methods (learning activities to be completed independently by the student)	Number of hours
CLO 1. Determine quantitative indicators of support and constraint reactions when calculating beams, trusses and other structural and mechanical elements and their components.	Presentation of examples of solving production problems using an interactive method during lectures and laboratory classes	26	Preparation for lectures by familiarizing yourself with the lecture material. Studying the material for independent mastery. Performing laboratory work tasks, the implementation of which was started in the laboratory session.	40
CLO 2. Design engineering structures and their elements taking into account engineering and resource-saving measures, social, environmental and technical-economic indicators, scientific and aesthetic aspects, current requirements of regulatory documentation, time and other constraints.	Presentation of examples of solving production problems using an interactive method during lectures and laboratory classes	14	Preparation for lectures by familiarizing yourself with the lecture material. Studying the material for independent mastery. Performing laboratory work tasks, the implementation of which was started in the laboratory session.	20
CLO 3. Understand the motion of machine elements and its main quantitative parameters. Be able to calculate these parameters and understand the operating principles of machines.	Presentation of examples of solving production problems using an interactive method during lectures and laboratory classes	10	Preparation for lectures by familiarizing yourself with the lecture material. Studying the material for independent mastery. Performing laboratory work tasks, the implementation of which was started in the laboratory session.	16
CLO 4. Be able to perform expert analysis of the load-bearing capacity of existing structures and elements during their operation and modernization.	Presentation of examples of solving production problems using an interactive	10	Preparation for lectures by familiarizing yourself with the lecture material. Studying the material for independent mastery. Performing laboratory	14

	method during lectures and laboratory classes		work tasks, the implementation of which was started in the laboratory session.	
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5. ASSESSMENT OF THE EDUCATIONAL COMPONENT

5.1. Summative assessment

5.1.1. For assessment of expected learning outcomes, the following is provided:

№	Summative assessment methods	Points / Percentage in the overall score	Date of compilation
	Semester 1 Module I		
1.	Completion and submission for assessment of laboratory reports according to the individual assignment. Defence of laboratory work through multiple-choice testing using the Moodle system	20 points / 20% 30 points / 30%	By the next laboratory class
	Semester 1 Module II		
2.	Completion and submission for assessment of laboratory reports according to the individual assignment. Defence of laboratory work through multiple-choice testing using the Moodle system	20 points / 20% 30 points / 30%	By the next laboratory class

5.1.2. Assessment criteria

1 semester

Component	Unsatisfactory	Satisfactory	Good	Excellent
Completion and defence of laboratory work	<60 points	60-74 points	75-89 points	90-100 балів
	Assignment requirements have not been met	Answers to all questions are provided, but individual components of the answers are missing or insufficiently disclosed, there is no analysis of other approaches to the question.	The answers to all questions are given	Answers to all questions are provided, creativity and thoughtfulness are demonstrated, and one's own solution to the problem is proposed.

5.2. Formative assessment:

The following are provided to assess current learning progress and identify areas for further improvement:

<i>№</i>	<i>Elements of formative assessment</i>	<i>Date</i>
1.	<i>Correctly completed tasks during laboratory classes with feedback from the lecturer.</i>	<i>During weeks 1–15</i>
2.	<i>Усний зворотний зв'язок від викладача під час роботи над завданнями протягом занять</i>	<i>During weeks 1–15</i>

Self-assessment may be used as an element of both summative and formative assessment.

6. LEARNING RESOURCES (LITERATURE)

1. Bulgakov V. M., Litvinov O. I., Voytyuk D. G. Engineering Mechanics. (Part 1. Theoretical Mechanics). / Edited by V. M. Bulgakov. Textbook. - Vinnytsia: Nova Kniga, 2022. - 504 p.
2. Bulgakov V. M., Litvinov O. I., Vaskov V. I., Golovachi. V., Voytyuk D. G. Theoretical Mechanics. Lecture course. Part I. - K.: NAU, 2021.-368 p.
3. Bulgakov V. M., Litvinov O. I., Vaskov V. I., Golovachi I. V., Voytyuk D. G. Theoretical Mechanics. Lecture course. Part II. - K.: NAU, 2021. - 342 p.
4. Dronnik Yu. M., Kucherenko S. I., Tishchenko A. M. Theoretical Mechanics. Lecture course. - Kharkiv: Olo, 2020. - 456 p.
5. Kaplunova A. V., Mykhailovsky V. A. et al. Methods and examples of solving problems in theoretical mechanics. - K.: Silhosposvita, 2000. - 365 p.
6. Pavlovsky M. A. Theoretical Mechanics. - K.: Tekhnika, 2021. -510 p.

Supplementary

7. Savyn G. N., Putyata T. V., Fradlin B. N. Theoretical Mechanics. - K.: Higher School, 2021. - 359 p.
8. Methodological instructions on the discipline "Theoretical Mechanics" for performing laboratory work for students Year 1 in the specialty 208 "Agroengineering" of the degree of higher education bachelor of full-time study / O. V. Radchuk, T. M. Kolodiy [Electronic resource], Sumy: SNAU, 2024. - 36 p.
https://newlibrary.snau.edu.ua/cgi-bin/koha/opac-detail.pl?biblionumber=123193&query_desc=%C2%AB%D0%A2%D0%B5%D0%BE%D1%80%D0%B5%D1%82%D0%B8%D1%87%D0%BD%D0%B0%20%D0%BC%D0%B5%D1%85%D0%B0%D0%BD%D1%96%D0%BA%D0%B0%C2%BB%20
9. Swivel auxiliary supply support with spherical base. Pat. 153759 U Ukraine, MPK B23Q 3/06 (2006.01) [Electronic resource] / P. V. Kushnirov, O. V. Ivchenko, V. O. Ivanov and others; applicant and patent owner SumDU. — No. u202204889 ; appl. 20.12.22 ; publ. 23.08.23, Bull. No. 34, Ukr. nat. office of intellectual property and innovations. — 9 p.
10. System of counter-rotating shafts. Pat. 153746 U Ukraine, MPK F16C 3/02 (2006.01), F16H 3/24 (2006.01), F16H 3/085 (2006.01) [Electronic resource] / O. A. Kulikov, O. V. Ratushny, O. V. Ivchenko and others; applicant and patentee SumDU. —

No. u202204645 ; appl. 08.12.22 ; publ. 23.08.23, Bull. No. 34, Ukr. nat. office of intellectual property and innovations. — 4 p.

11. Scientific foundations of machine assembly: teaching manual / V. I. Savchuk, O. V. Ivchenko, A. V. Yevtukhov, I. M. Degtyarev ; general editor A. V. Yevtukhova. Sumy: Sumy State University, 2023. 277 p.

<https://essuir.sumdu.edu.ua/handle/123456789/93153>

12. Special hydraulic machines [Text]: textbook. / V.O. Panchenko, O.V. Ivchenko, S.S. Meleychuk, E.V. Kolisnichenko, O.V. Ryasna; ed. V. O. Panchenko. — Sumy: SumDU, 2021. — 229 p.

<https://essuir.sumdu.edu.ua/handle/123456789/83667>

13. Panchenko, V.O. Operation of pumping station equipment [Text]: textbook. / V.O. Panchenko, V.F. German, O.V. Ivchenko et al.; ed. ed. V.O. Panchenko. — Sumy: SumDU, 2020. — 270 p.

<https://essuir.sumdu.edu.ua/handle/123456789/78894>

14. Improving the regulatory framework for instrumental preparation of production to improve technical and economic indicators [Text]: monograph / Yu.O. Denysenko, V.O. Zaloga, O.V. Ivchenko. — Sumy: SumDU, 2020. — 93 p.

Software

15. Design libraries of the SolidWorks computer-aided design system.