

**Syllabus selective component**  
**Actual aspects of the modern knowledge about nature.**

Subjects:	<b>Actual aspects of the modern knowledge about nature. Mechanics.</b>
Level of higher education:	<b>First (undergraduate)</b>
Course page in Moodle:	<a href="https://dl2022.khadi-kh.com/course/view.php?id=3587">https://dl2022.khadi-kh.com/course/view.php?id=3587</a>
The scope of the educational component	<b>3 credits (90 hours)</b>
Final control form	<b>Test</b>
Consultations:	<b>on schedule</b>
Name of the department:	<b>Department of Physics</b>
Teaching language:	<b>English</b>
Course leader:	<b>Yury Viktorovich Batygin, Ph.D., professor</b>
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**Brief content of the educational component:**

**The goal** is to learn the regularities of the physical picture of the world, as an integral component of the modern scientific worldview of future specialists; fundamental training of specialists capable of solving a complex of professional engineering practice problems related to various technological problems.

**Subject:** theoretical and methodological foundations of innovations in modern road and automobile industries, methodological provisions of scientific directions of industrial technologies.

**The main tasks of studying an academic discipline are:**

- substantiation and presentation of the unified theoretical and methodological foundations of modern innovations;
- study of the genesis of the modern introduction into practice of new processes and devices;
- formation of directions for improvement and development of industrial technologies;
- formation of skills in the organization of independent research work and presentation of the results of scientific research.

**Prerequisites for studying the educational component:**

Higher mathematics; Physics.

**Competencies acquired by the acquirer:**

**General competences:**

- Ability to learn and master modern knowledge.
- Ability to apply knowledge in practical situations.
- Ability to perform safe activities

**Special (professional) competences:**

The ability to apply fundamental knowledge to analyze phenomena of natural and man-made origin when performing professional tasks.

Ability to apply theories, principles, methods of physical and mathematical, natural, socio-economic, engineering sciences when performing professional tasks.

The ability to choose and use effective methods, technologies and equipment for carrying out professional activities.

The ability to use tools, devices, equipment, and equipment when performing professional tasks.

**Learning outcomes according to the educational program:**

Apply conceptual knowledge of natural sciences when performing professional tasks.

Carry out surveys and research, engineering, design and project-research work when performing professional tasks.

### Thematic plan

No. of topic	Name of topics	Number of hours
1	<b>L</b> Disclosure of the nature of physical phenomena as the basis of theoretical substantiation of modern innovative applications in technology. Kinematics of a material point, general definitions. Curvilinear movement.	2
	<b>PL</b> Examples of calculating the kinematic characteristics of a car. Physical quantities, their main properties.	2
	<b>IW</b> Kinematic characteristics of rotational movement, the relationship between them	8
2	<b>L</b> Dynamics of a material point. Basic concepts of translational movement dynamics. Newton's laws. Pulse. Law of conservation of momentum.	2
	<b>PL</b> Dynamics of a material point. Solving problems.	2
	<b>IW</b> Examples of calculating traction forces when towing a car. Motion of a body of variable mass. Jet motion	8
3	<b>L</b> Types of interactions. Fundamental interactions in nature. The law of universal gravitation. Elastic forces. Frictional forces	2
	<b>PL</b> The nature of mechanical forces. The method of determining the forces acting on the body. Solving problems.	2
	<b>IW</b> Body weight in different systems. A car on a convex bridge.	8
4	<b>L</b> Types of interactions. Fundamental interactions in nature. The law of universal gravitation. Elastic forces. Frictional forces	2
	<b>PL</b> Using the kinetic energy theorem. Solving problems.	2
	<b>IW</b> Graphic representation of work. Calculation of work of variable force	8
5	<b>L</b> Force fields. Potential energy. Law of conservation of energy. Elastic and inelastic shocks	2
	<b>PL</b> Using the laws of conservation of energy and momentum to solve problems	2
	<b>IW</b> Methods of determining a closed system and a potential field. Gravitational field. Movement of bodies in the central gravitational field. Space speeds.	8
6	<b>L</b> Elements of solid body mechanics. Kinematic relations. Determination of moment of force. The main equation of the dynamics of rotational motion. Moment of inertia, moment of momentum of a rigid body	2
	<b>PL</b> Application of the basic equation of the dynamics of rotary motion. Solving problems	2
	<b>IW</b> Free axes of rotation. Balance conditions of the body. Rotation of the body relative to the point. Gyroscopes.	8
7	<b>L</b> Oscillations in mechanics. Periodic processes, fluctuations. Harmonic oscillations. Mathematical and physical pendulums. Damping oscillations. Forced oscillations, resonance.	2
	<b>PL</b> Methods of calculating oscillation parameters. Mechanical oscillations in resonance. Solving problems	2
	<b>IW</b> Adding oscillations. Mechanical waves. Energy of wave motion, flow of energy. Ultrasound and its application	8
8	<b>L</b> Inertial reference systems. Galileo's Principle of Relativity Relativistic mechanics. Lorentz transformation. Consequences of Lorentz transformations	2

	<b>PL</b> Calculation methods in different inertial frames of reference. Solving problems	2
	<b>IW</b> Laws of conservation of mass, energy and momentum in the special theory of relativity.	2
<b>Together</b>	<b>L</b>	16
	<b>PL</b>	16
	<b>IW</b>	58

### Teaching methods:

- 1) *verbal*:
  - 1.1 traditional: lectures, explanations, stories, etc.;
  - 1.2 interactive (non-traditional): problem lectures, discussions, etc.;
- 2) *visual*: method of illustrations, method of demonstrations
- 3) *practical*:
  - 3.1 traditional: practical classes, seminars;

### Evaluation system and requirements:

#### Current performance

1 The current success of applicants for the performance of educational types of work in training sessions and for the performance of independent work tasks is evaluated using a four-point rating scale with subsequent transfer to a 100-point scale. During the evaluation of the current academic performance, all types of work provided by the educational program are taken into account.

- 1.1 Lecture classes are evaluated by determining the quality of performance of specified tasks.
- 1.2 Practical classes are evaluated by the quality of performance of a control or individual task, performance and design of practical work.
- 1.3 Laboratory classes are evaluated by the quality of reports on the performance of laboratory work.
- 1.4 Seminar classes are evaluated by the quality of individual assignment/abstract.

2 The current performance of higher education applicants is assessed at each practical session (laboratory or seminar) on a four-point scale ("5", "4", "3", "2") and entered in the journal of academic performance.

- “excellent”: the winner mastered the theoretical material flawlessly, demonstrates deep knowledge of the relevant topic or academic discipline, the main provisions;
- "good": the applicant has mastered the theoretical material well, has the main aspects from primary sources and recommended literature, presents it in a reasoned manner; has practical skills, expresses his thoughts on certain problems, but certain inaccuracies and errors are assumed in the logic of the presentation of theoretical content or in the analysis of practical ones;
- "satisfactory": the applicant has basically mastered the theoretical knowledge of the educational topic or discipline, orients himself in primary sources and recommended literature, but answers unconvincingly, confuses concepts, answers additional questions uncertainly, does not have stable knowledge; when answering questions of a practical nature, reveals inaccuracy in knowledge, does not know how to evaluate facts and phenomena, connect them with the future profession;
- "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, hardly orients himself in primary sources and recommended literature, lacks scientific thinking, practical skills are not formed.

3 The final score for the current activity is recognized as the arithmetic mean sum of points for each lesson, for individual work, current control works according to the formula:

$$K^{current} = \frac{K1 + K2 + \dots + Kn}{n},$$

where  $K^{current}$  is the final assessment of success based on the results of current control;

$K1, K2, \dots, Kn$  – evaluation of the success of the current control measure;  
 $n$  – the number of measures of current control.

Assessments are converted into points according to the calculation scale (table 1).

**Table 1** – Recalculation of the average grade for the current activity into a multi-point scale

4-point scale	100-point scale	4-point scale	100-point scale	4-point scale	100-point scale	4-point scale	100-point scale
5	100	4,45	89	3,90	78	3,35	67
4,95	99	4,4	88	3,85	77	3,3	66
4,9	98	4,35	87	3,80	76	3,25	65
4,85	97	4,3	86	3,75	75	3,2	64
4,8	96	4,25	85	3,7	74	3,15	63
4,75	95	4,20	84	3,65	73	3,1	62
4,7	94	4,15	83	3,60	72	3,05	61
4,65	93	4,10	82	3,55	71	3	60
4,6	92	4,05	81	3,5	70	from 1.78 to 2.99	from 35 to 59
						reassembly	
4,55	91	4,00	80	3,45	69	from 0 to 1.77	from 0 to 34
4,5	90	3,95	79	3,4	68	repeated study	

### Final assessment

1 A student of higher education receives a credit in the last lesson in the discipline based on the results of the current assessment. The average score for the current activity is converted into points on a 100-point scale, according to the conversion table (table 1).

Applicants for higher education who have a current grade point average in the discipline lower than "3" (60 points) can increase their current grade by taking tests in the discipline in the last session.

Assessment of the knowledge of applicants through testing is carried out according to the following scale:

- "Excellent": at least 90% of correct answers;
- "Very good": from 82% to 89% of correct answers;
- "Good": from 74% to 81% of correct answers;
- "Satisfactory": from 67% to 73% of correct answers;
- "Satisfactory enough": from 60% to 66% of correct answers;
- "Unsatisfactory": less than 60% of correct answers.

2 The condition for obtaining credit is: - making up for all missed classes; – the average current grade in the discipline is not lower than "3" (60 points).

3 For performing individual independent work and participation in scientific events, additional points are awarded to the winners.

3.1 Additional points are added to the sum of points scored by the student of higher education for the current educational activity (for disciplines for which the final form of control is a credit), or to the final grade in the discipline for which the final form of control is an exam.

3.2 The number of additional points awarded for different types of individual tasks depends on their volume and importance:

- prizes in the discipline at the international / all-Ukrainian competition of scientific student works - 20 points;

- prize places in the discipline at the All-Ukrainian Olympiads - 20 points;
- participation in the international / all-Ukrainian competition of scientific student works - 15 points
- participation in international / all-Ukrainian scientific conferences of students and young scientists - 12 points;
- participation in all-Ukrainian Olympiads in the discipline - 10 points - participation in Olympiads and scientific conferences of the Khnadu in the discipline - 5 points;
- performance of individual scientific and research (educational and research) tasks of increased complexity - 5 points.

3.3 The number of additional points cannot exceed 20 points.

4 The learning outcome is evaluated: – on a 100-point scale (for differentiated assessment) according to table 2. The final grade together with additional points cannot exceed 100 points. Table 2 – The scale for evaluating the knowledge of students based on the resul

**Table 2** – The scale for evaluating the knowledge of students based on the results of the final control of the academic discipline

Evaluation in points	Evaluation according to the national scale		Evaluation according to the ECTS scale	
	examination	credit	Assessment Criteria	Assessment Criteria
<b>90-100</b>	<b>Perfectly</b>	<b>Enrolled</b>	<b>A</b>	The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have been formed, all educational tasks provided for in the training program have been completed, the quality of their performance has been assessed with a number of points close to the maximum
<b>80-89</b>			<b>B</b>	The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have mainly been formed, all educational tasks provided for by the training program have been completed, the quality of most of them has been assessed with a number of points close to the maximum
<b>75-79</b>			<b>C</b>	The theoretical content of the course has been mastered in its entirety, without gaps, some practical skills of working with the mastered material have not been formed enough, all educational tasks provided for by the training program have been completed, the quality of none of them has been assessed with a minimum number of points, some types of tasks have been completed with errors

Evaluation in points	Evaluation according to the national scale		Evaluation according to the ECTS scale	
	examination	credit	Assessment Criteria	Assessment Criteria
<b>67-74</b>	<b>Satisfactorily</b>		<b>D</b>	The theoretical content of the course is partially mastered, but the gaps are not of a significant nature, the necessary practical skills for working with the mastered material are basically formed, most of the educational tasks provided by the training program have been completed, some of the completed tasks may contain errors
<b>60-66</b>			<b>E</b>	The theoretical content of the course has been partially mastered, some practical work skills have not been formed, many educational tasks provided by the training program have not been completed, or the quality of some of them has been assessed with a number of points close to the minimum.
<b>35-59</b>	<b>Unsatisfactorily</b>	<b>Not counted</b>	<b>FX</b>	The theoretical content of the course has been partially mastered, the necessary practical work skills have not been formed, most of the prescribed training programs of educational tasks have not been completed, or the quality of their implementation has been assessed with a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the performance of educational tasks (with the possibility of retaking)
<b>0-34</b>	<b>Unacceptable</b>		<b>F</b>	The theoretical content of the course has been partially mastered, the necessary practical work skills have not been formed, most of the prescribed training programs of educational tasks have not been completed, or the quality of their implementation has been assessed with a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the performance of educational tasks (with the possibility of retaking)

**Course policy:**

- the course involves working in a team, the environment in the classroom is friendly, creative, open to constructive criticism;
- mastering the discipline involves mandatory attendance of lectures and practical classes, as well as independent work;

- independent work involves the study of individual topics of the academic discipline, which are presented in accordance with the program for independent study, or were considered briefly;
- all tasks provided by the program must be completed within the set time;
- if the student of higher education is absent from classes for a good reason, he presents the completed tasks during independent preparation and consultation of the teacher;
- while studying the course, students of higher education must adhere to the rules of academic integrity set forth in the following documents: "Rules of academic integrity of participants in the educational process of the Khnadu" ([https://www.khadi.kharkov.ua/fileadmin/P\\_Standart/pologeniya/stvnz\\_67\\_01\\_dobroch\\_1.pdf](https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.pdf)), "Academic integrity. Checking the text of academic, scientific and qualification works for plagiarism" [https://www.khadi.kharkov.ua/fileadmin/P\\_Standart/pologeniya/stvnz\\_85\\_1\\_01.pdf](https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_85_1_01.pdf) "Moral and ethical code of participants in the educational process of the Khnadu" ([https://www.khadi.kharkov.ua/fileadmin/P\\_Standart/pologeniya/stvnz\\_67\\_01\\_MEK\\_1.pdf](https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf)).
- in case of detection of plagiarism, the applicant receives 0 points for the task and must repeat the tasks provided for in the syllabus;
- writing off during tests and exams is prohibited (including using mobile devices). Mobile devices are allowed to be used only during online testing.

### Recommended Books:

1. Distance course: <https://dl2022.khadi-kh.com/course/view.php?id=3587>
2. Noah M MacKay. Theory of Physics, Volumes 1 & 2: Classical Mechanics & Electromagnetism (The Theory of Physics). Independently published (November 23, 2020), 221 p.
3. Julio Gea-Banacloche. University Physics I: Classical Mechanics. University of Arkansas, Fayetteville, 2019. 405 p.
4. Salma Alrasheed. Principles of Mechanics. Fundamental University Physics. Springer Cham. 2019. 173 p.

### Supporting literature

1. Peter Mann. Dynamics. Illustrated Edition. Oxford University Press. 2018, 560 p.
2. Atam Arya. Introduction to Classical Mechanics. 2nd Edition, Pearson; 1977. 720 p.
3. Kai S Lam. Fundamental principles of classical mechanics: a geometrical perspective. World Scientific Publishing Company, 2014. 592 p.
4. Hiqmet Kambara. Classical Mechanics. De Gruyter, 2021. 344 p.

### Additional sources:

1. Outline of lectures: <https://dl2022.khadi-kh.com/mod/folder/view.php?id=250640>
2. File archive of the Khnadu: <http://files.khadi.kharkov.ua/>
3. Scientific library of Khnadu <http://library.khadi.kharkov.ua/golovna/>
4. Classical Mechanics Lessons and Examples <https://cosmolearning.org/courses/classical-mechanics-tutorials-examples/>

Developer of the syllabus  
of the academic discipline

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