Syllabus
selective component
Theory of mechanisms and machines

Subjects:	**Theory of mechanisms and machines**
Level of higher education:	**First (undergraduate)**
Course page in Moodle:	https://dl2022.khadi-kh.com/course/view.php?id=2522
The scope of the educational component	**4 credits (120 hours)**
Final control form	**Test**
Consultations:	**on schedule**
Name of the department:	**Machine Components and Theory of Machines and Mechanisms**
Teaching language:	**English**
Course leader:	**Andrey Sharapata, candidate of technical sciences, associate professor**
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Brief content of the educational component:

The goal of studying the academic discipline is to prepare specialists at the bachelor's level in the field of modern methods of building machines and mechanisms, researching their movement, force analysis and balancing of mechanisms, friction in machines and mechanisms, vibration activity and vibration protection of lever mechanisms, synthesis of gear and cam mechanisms -movement management of executive bodies of machines and machine systems.

Subject: theoretical, practical and methodological bases of analysis and synthesis of mechanisms and machines.

The main tasks of studying an academic discipline are:

- - finding kinematic and dynamic characteristics of the mechanisms being designed;
- drawing up kinematic schemes of mechanisms;
- performance of kinematic analysis and synthesis of mechanisms under given conditions;
- - performance of geometrical calculation of gears by engagement;
- study of the dynamics of movement of mechanisms;
- performance of force calculation of the main types of mechanisms;
- balancing mechanisms.

Prerequisites for studying the educational component:
Physics, Higher mathematics, Graphic geometry, engineering and computer graphics, Theoretical mechanics.

Competences acquired by the acquirer:

General competences:

Ability to communicate in a foreign language (English).

The ability to communicate with the scientific community in order to present the results of scientific research and make them public in English.

Ability to think critically, generate new complex ideas, analyze and synthesize holistic knowledge.

Ability to organize and conduct original scientific research.

Knowledge and understanding of the subject area and professional engineering activities.

Special (professional) competences:

Ability to use professional terminology in a foreign language.

Ability to search, process and analyze and summarize information for conducting independent scientific research.

Ability to formulate and perform tasks of design and analysis of existing models.

Ability to perform analysis of various parts and products, evaluate their operational, technical and economic, technological functions.

Ability to apply typical analytical methods and computer programs for solving engineering problems of mechanical engineering, effective quantitative methods of mathematics, physics, engineering sciences, as well as appropriate computer software for solving engineering problems of mechanical engineering.

Ability to apply fundamental scientific facts, concepts, theories, principles to solve professional problems and practical problems of mechanical engineering.

Ability to develop taking into account safety, economic, ecological and aesthetic parameters technical tasks and technical conditions for design objects of road transport, its systems and individual elements; make accommodation plans equipment, technical equipment and organization jobs, calculate loading equipment and technological quality indicators processes.

Learning outcomes according to the educational program:

To have the conceptual scientific and practical knowledge necessary to solve specialized complex problems of road transport, to critically consider relevant theories, principles, methods and concepts.

Apply specialized software, information and information and communication technologies to research models of objects and processes of road transport, operational properties of road vehicles, carry out engineering and technical and economic calculations, create design and construction documentation and solve other problems of road transport.

Plan and carry out measurement experiments using appropriate equipment, analyze their results.

Participate in the development and implementation of engineering and/or production projects in the field of road transport, determine the duration and sequence of works, resource needs, forecast the consequences of project implementation.

Use mathematical and statistical methods to construct and research of models of objects and processes of road transport, calculation of their characteristics, forecasting and solving of other complex problems of road transport.

To present the results of research and professional activities to specialists and non-specialists, to argue their position.

Thematic plan

Topic No		**Name of topics LL, PL, IW)**	Number of hours	
			ocular	extramural
1	LL	Introduction to TMM	1	
	PL			
	IW			
2	LL	Structural analysis of mechanisms	2	0.5
	PL	Structural analysis of lever mechanisms.	4	
	IW	Structural analysis of lever mechanisms.	4	6
3	LL	The number of degrees of freedom (DOF) for plane mechanism. Chebyshev's formula.	1	0.5
	PL	Metric synthesis of lever mechanisms.	4	1
	IW	Metric synthesis of the lever mechanism from the task on CP.	8	10
4	LL	Kinematics of lever mechanisms. Introduction.	1	1
	PL	Kinematics of lever mechanisms by the plan method.	4	
	IW	Drawing of the plan of velocities for the lever mechanism from the task on CP.	8	12
5	LL	Kinematics of lever mechanisms. Resultant motion (Compound motion / Complex motion).	1	1
	PL	Kinematics of lever mechanisms by the plan method.	4	
	IW	Drawing of the plan of velocities for the lever mechanism from the task on CP.	8	12
6	LL	Kinematics of lever mechanisms. Velocities plan and accelerations plan.	2	1
	PL	Kinematics of lever mechanisms by the plan method.	4	1
	IW	Drawing of the plan of accelerations for the lever mechanism from the task on CP.	12	14
7	LL	Reducing of forces and masses.	2	1
	PL	Reducing of forces and masses.	4	1
	IW	Reducing of forces and masses for the lever mechanism from the task on CP.	12	16
8	LL	Kinetostatics of lever mechanisms.	2	1
	PL	Kinetostatics of lever mechanisms.	4	1
	IW	Kinetostatics of lever mechanisms.	8	16
9	LL	Power transmissions.	1	0.5
	PL	Determination of the transmission ratio of multi-link gears.	2	

	IW	Determination of the transmission ratio of multi-link gears.	4	4
10	LL	Gears.	2	0.5
	PL	Kinematic analysis of multi-link gears with fixed shaft axes.	2	
	IW	Kinematic analysis of multi-link gears with fixed shaft axes.	4	8
12	LL	Geometry of gears.	1	1
	PL			
	IW	Geometrical parameters of straight-toothed involute gears.	4	10
Together	LL		16	8
	PL		32	4
	IW		72	108

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.
2 The current performance of higher education applicants is assessed at each practical session (laboratory or seminar) on a four-point scale ("5", "4", "Z", "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 way; 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;
– "**Satisfactorily**": 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;
– "**Unsatisfactorily**": 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:

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

where $K^{current}$ is the final assessment of success based on the results of current control;
$K1, K2, ..., Kn$ – evaluation of the success n 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 points scale	4-ball scale	100 points scale	4-ball scale	100 points scale	4-ball scale	100 points 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 results of the final control of the academic discipline

Score in points	Evaluation on a national scale		Evaluation according to the ECTS scale	
	examination	test	Rating	Criteria
90-100	**Excellent**	**Enrolled**	**A**	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
80–89	**Good**	**Enrolled**	**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
75-79			**C**	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
67-74	**Satisfactorily**		**D**	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

Score in points	Evaluation on a national scale		Evaluation according to the ECTS scale	
	examination	test	Rating	Criteria
60–66			**E**	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.
35–59	**Unsatisfactorily**	**Not counted**	**FX**	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)
0–34	**Unacceptable**		**F**	The theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all completed educational tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the performance of educational tasks (with a mandatory repeat course)

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, 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 comply with the rules of academic integrity set forth in the following documents: "Rules of academic integrity of participants in the educational process of the KhNAHU" (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 papers for plagiarism" (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 KhNAHU (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:

Basic literature

1.1. Artobolevsky I. I. Theory of mechanisms and machines //Textbook for higher technical educational institutes,«Science», Moscow. – 1988. – T. 640.
1.2. Kolovsky M. Z. et al. Advanced theory of mechanisms and machines. – Springer Science & Business Media, 2012.
1.3. John J. Uicker, Jr., Gordon R. Pennock, Joseph E. Shigley. Theory of Machines and Mechanisms. - New York, Oxford, Oxford University Press, 2017. – 978 p.
1.4. Sharma C. S., Purohit K. Theory of mechanisms and machines. – PHI Learning Pvt. Ltd., 2006.
1.5. Dukkipati R. V. Mechanism and machine theory. – bohem press, 2007.
1.6. Distance course:
https://dl2022.khadi-kh.com/course/view.php?id=2522

Supporting literature

2.1. Ambekar A. G. Mechanism and machine theory. – PHI Learning Pvt. Ltd., 2007.
2.2. Zhonghe Y. et al. Mechanisms and machine theory. – Beijing : Higher Education Press, 2001.
2.3. Zakhovaiko, O. P. Theory of Mechanisms and Machines, Part 1 / O. P. Zakhovaiko. – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2020. – 188 p.
2.4. Zakhovaiko, O. P. Theory of Mechanisms and Machines, Part 2 / O. P. Zakhovaiko – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2021. – 184 p.
2.5. Kishan Kanani. Machines and Mechanisms. - Department of Mechanical Engineering Darshan Institute of Engineering and Technology. - Rajkot, 2019. – 201 p.

Additional sources:

1. distance course:
https://dl2022.khadi-kh.com/course/view.php?id=2522
2. distance course:
https://dl2022.khadi-kh.com/course/view.php?id=3506
4. Summary :
https://dergipark.org.tr/tr/pub/ij3dptdi/issue/73017/1187111

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