Syllabus
selective component of VD
(conditional designation OK in the educational program (OP))

Basics of 3D modeling

Subjects:	**Basics of 3D modeling**
Level of higher education:	**first (undergraduate)**
Course page in Moodle:	*https://dl2022.khadi-kh.com/course/view.php?id=3966*
The scope of the educational component	**4 credits (120 hours)**
Final control form	**Test**
Consultations:	**on schedule**
Name of the department:	**department of engineering and computer graphics**
Teaching language:	**English**
Course leader:	**Chernikov Oleksandr Viktorovych, doctor of technical sciences, professor**
Contact phone number:	*057-707-37-24*
Email:	*Ikg@khadi.kharkov.ua*

Brief content of the educational component:
The goal is training of specialists in the field of application of modern design tools and geometric computer modeling of machine-building objects and processes corresponding to them. One of the constituent parts of the process of design and construction of parts and assemblies of products is the development of design documentation, including drawings. It is especially valuable to acquire the skills of applying geometric modeling when solving spatial problems.
Subject : the study of the educational discipline is a pedagogically adapted system of concepts about the principles of modeling three-dimensional objects using two-dimensional projection images of draftsmen.
The main tasks of studying an academic discipline are:
- formation of knowledge, abilities and skills in the execution of blueprints for various purposes;
- development of spatial perception, necessary for the creation of new structures;
- mastering the methods of reflection on the plane of spatial objects;
- ability to create drawings using computer technologies.

Prerequisites for studying the educational component: the discipline is based on the preliminary training of students in engineering and computer graphics, informatics within the programs of educational institutions of higher education, as well as knowledge of the basics of the fundamental sections of the disciplines of higher mathematics, informatics and computer technology in accordance with the requirements of the chosen profession

Competencies acquired by the acquirer:
General competences **:**
- The ability to apply knowledge, demonstrating a professional approach in one's activities, which allows solving tasks in the field of lifting and transport, construction, road and reclamation machines.
- Ability to gather and interpret information and express judgments about relevant social, scientific or ethical problems.
- The ability to critically understand the theories and principles underlying the design of

lifting and transport, construction, road and reclamation machines.

Professional competences:

- Ability to apply typical analytical methods and computer software for solving engineering tasks in the field of lifting and transport, construction, road and reclamation engineering.
- The ability to apply fundamental scientific facts, concepts, theories, principles to solve professional tasks and practical problems of industrial engineering.
- Ability to use computerized design systems and specialized application software to solve engineering tasks in the field of mechanical engineering.
- The ability to find and use interdisciplinary and interdisciplinary connections in scientific activity.

Learning outcomes :

- Knowledge and understanding of the basics of technological, fundamental and engineering sciences, which are the basis of lifting and transport, construction, road and reclamation engineering.
- Knowledge and understanding of mechanics and lifting and transport, construction, road and reclamation engineering and prospects for their development.
- Search for the necessary scientific and technical information in available sources, in particular, in a foreign language, analyze and evaluate it.
- To understand the relevant methods and to have the skills to design typical nodes and mechanisms in accordance with the task.

Thematic plan

Topic No	Name of topics (LK, LR, PR, SZ, SR)	Number of hours	
		ocular	extra-mural
1	**LK.** Basics of parametric 3D modeling in the Autodesk Inventor package, parametric sketches and working elements, use of geometric and dimensional dependencies. Possibilities of using the MS Excel package and the imitation mechanism to ensure the connection between the dimensions of the parts in the node, the features of the parameterization of the part models.	4	1 , 0
	PR. Basics of work in the package: features of the interface and debugging of the program, modeling environment, sketches, assembly and drafters. Creation of parametric models of the node, assembly, drawings and specifications. Development of parametric series of details.	4	1 , 0
	SR. on topic 1.	16	2 2
2	**LK.** Methods of geometric modeling on a plane and in space, basics of parameterization theory, models of curved lines and surfaces, methods of interpolation, extrapolation and approximation, uniform coordinates and affine transformations.	4	1 , 0
	PR. Use of parameterization theory to determine the required number of parameters of geometric objects, use of formulas for construction of plane and spatial curves.	4	1 , 0
	SR. on topic 2.	16	2 2
3	**LK.** The use of design masters in the modeling of connections, shafts, gear and belt gears, springs, etc., built-in engineering calculations, analysis of the absence of intersection of assembly elements; editing and creating parts in the assembly unit environment. Draftsmen	4	1 , 0

	PR. Practical work on the use of masters of designing shafts, toothed/spline couplings, principles of using dialog boxes when creating 3D models. Work in the "Kreslenik" environment, methods of creating design documentation.	4	1 , 0
	SR. on topic 3.	28	3 4
4	**LK.** The concept of a digital prototype: animation of the operation of the mechanism, diagrams of assembly and disassembly of node models. Dynamic modeling environment, types of contacts, their difference from component dependencies, devices for graphic input and output of engineering information.	4	1 , 0
	PR. Imposition of conditions for modeling the operation of nodes and mechanisms, imitation of component dependencies or task of connections in a dynamic modeling environment; assignment of driving conditions using constants and graphs. Analysis of speeds and accelerations of mechanism elements.	4	1 , 0
	SR. on topic 4.	28	3 4
Together	LK.	16	4
	PR.	16	4
	SR.	88	11 2

Individual educational and research task: not provided.

Teaching methods:

- verbal method (lecture, explanation, story);
- practical method (practical classes, performing exercises, performing situational tasks);
- visual method (illustration method, demonstration method);
- working with literature (educational and methodical; scientific literature; normative literature; working with textbooks and manuals; searching for information by task);
- in combination with the latest information technologies and computer training tools (distance, multimedia, virtual models of physical processes; web-oriented, etc.);
- independent work;

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 for 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", "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 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 test works according to the formula:

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

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

$K1, K2, \ldots, Kn$ – 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 test), 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 result is evaluated *(select required)* :
– on a two- point scale (passed/failed) according to table 2;
– on a 100-point scale (for differentiated assessment) according to table 3.
The final grade together with additional points cannot exceed 100 points.

Table 2 – Scale for transferring points to the national evaluation system

On a 100-point scale	**On a national scale**
from 60 points to 100 points	counted
less than 60 points	not counted

Table 3 – The scale for evaluating the knowledge of the 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	**Perfectly**	**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

<table>
<tr><td rowspan="2">Score in points</td><td colspan="2">Evaluation on a national scale</td><td colspan="2">Evaluation according to the ECTS scale</td></tr>
<tr><td>examination</td><td>test</td><td>Rating</td><td>Criteria</td></tr>
<tr><td>80–89</td><td rowspan="2">Okay</td><td rowspan="4">Enrolled</td><td>B</td><td>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</td></tr>
<tr><td>75-79</td><td>WITH</td><td>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</td></tr>
<tr><td>67-74</td><td rowspan="2">Satisfactorily</td><td>D</td><td>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</td></tr>
<tr><td>60–66</td><td>E</td><td>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.</td></tr>
<tr><td>35–59</td><td>Unsatisfactorily</td><td rowspan="2">Not counted</td><td>FX</td><td>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)</td></tr>
<tr><td>0–34</td><td>Unacceptable</td><td>F</td><td>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)</td></tr>
</table>

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;
- the coursework must be protected no later than a week before the beginning of the examination session ***(indicated if available)*** **;**
- 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), "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 Khnadu (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 literature:

1. Mykhaylenko V.E. Engineering and computer graphics / V.E. Mykhaylenko, V.M. You will find –Kyiv. High school. 2011 – 342 p.
2. Vanin V.V., Perevertun V.V., Nadkernychna T.M., Vlasyuk H.G. Engineering graphics. - K.: BHV Publishing Group, 2018 . - 400 p.
3. Basics of computer modeling in engineering: a study guide / V. D. Borysenko, S. A. Ustenko, I. V. Ustenko. Mykolaiv: MNU, 2016. 276 p.
4. Chern ikov O. V. Video course on creating models of parts, assemblies and drawings in the Autodesk environment Inventor . URL: https://cutt.ly/92cED59
5. Dov and dkova system : Autodesk Inventor Help. URL: https://help.autodesk.com/view/INVNTOR/202 3 /ENU/
6. Methodical instructions for independent work on engineering graphics on the topics "folding drawing", "detailing" for students of technical specialties / O.V. Arkhipov, Ya.A. Kovaleva, V.I. Hopper. - Kh.: Khnadu, 2014. - 64 p.
7. Chernikov O.V., Arkhipov O.V., Yermakova O.A., Koretskyi J.S. Using the shaft component generator to model typical parts in Autodesk Inventor. *Applied issues of mathematical modeling* : scientific journal. Vol. 4, No. 2.1. Kherson: Kherson National Technical University, 2021. P. 253-260. DOI: https://doi.org/10.32782/KNTU2618-0340/2021.4.2.1.27
8. Kyrychenko I.G., Chernikov O.V., Rogovii A.S., Ragulin V.M., Reznikov O.O., Taburov O.S. Peculiarities of computer modeling and study of operating modes of elements of the lifting platform. *Bulletin of the Kharkiv National Automobile and Road University* . Coll. scientific works. 2021. Issue 95. P. 143–148. DOI: https://doi.org/10.30977/BUL.2219-5548.2021.95.0.143
9. Chernikov O.V. Expanding the possibilities of computer modeling due to the use of API (using the Autodesk Inventor package as an example). *Bulletin of Kharkiv National Automobile and Road University* . Coll. scientific works. 2022. Issue 99. P. 111–117. DOI: https://doi.org/10.30977/BUL.2219-5548.2022.99.0.111

Additional sources:

1. Peter RN Childs Mechanical Design : Engineering Handbook (Second edition). Elsevier: 2019. 982p.

2. Yu. M. Kovalev , V. M. Vereshchaga. Applied geometry: textbook. K.:, 2012. 472 p.
3. Distance course: https://dl.khadi.kharkov . ua/course/view.php?id=3678
4. Inventor for Mechanical Design Learning Pathway : Explore courses and skills that help you become an Autodesk Certified Professional in Inventor for Mechanical Design. Learn at your own pace, track your progress, and determine your path forward (Mechanical Design Inventor Learning Path: Learn the courses and skills that will help you become an Autodesk Certified Mechanical Design Inventor Professional. Learn at your own pace pace, track your progress and determine your path forward) . URL: https://www.autodesk.com/certification/learning-pathways/inventor-mechanical-design
5. Inventor . Support and learning (resources for learning) . URL : https://knowledge.autodesk.com/support/inventor

Developer
of the syllabus of the educational discipline _____ Oleksandr CHERNIKOV
signature

Head of the engineering department
and computer graphics _____ Oleksandr CHERNIKOV
signature