Syllabus
selective component SC

Basics of 3D modeling

Subjects:	**Basics of 3D modeling**
Level of higher education:	**the first (bachelor's)**
Course page in Moodle:	**https://dl2022.khadi-kh.com/course/view.php?id=1963**
The scope of the educational component	**4 credits (120 hours)**
Final control form	**Test**
Consultations:	**on schedule**
Name of the department:	**department of metal technology and materials science**
Teaching language:	**Ukrainian**
Course leader:	**Dudukalov Yurij, Ph.D., associate professor**
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Brief content of the educational component:

The aim is to form a set of knowledge, skills and abilities for students to solve mechanical engineering problems in 3D modeling for design and technological support for the selection and processing of modern structural and instrumental materials. Within the framework of the bachelor's program of the course "Fundamentals of 3D modeling" students study computer modeling methods and their practical application for machining on CNC machines, research of physical and mechanical properties of materials on the basis of the educational and technological center "KNADU-HAAS", which is equipped with a milling machine VF2 and a lathe ST20 manufactured by HAAS (USA).

Subject: practical basics of computer 3D modeling for design and technological support for the selection and processing of modern structural and tool materials on CNC equipment.

The main tasks of studying an academic discipline are:
- obtaining knowledge and skills of practical application of computer 3D modeling methods;
- three-dimensional computer modeling of parts and products of special structure from powder composite materials and reinforced polymers;
- procedure for technological preparation of production for CNC equipment by methods of computer 3D modeling;
- mastering of computer 3D modeling methods for thermal processes;
- application of computer 3D modeling methods for the study of physical and mechanical characteristics of materials;
- mastering of computer 3D modeling methods for power processes;
- study of the basic principles and concepts of computer 3D modeling;
- formation of skills in the application of computer 3D modeling methods in the work of a materials scientist.

Prerequisites for studying the educational component:
Fundamentals of programming.
Graphic geometry, engineering and computer graphics.
History of engineering activity.
Construction materials technology and materials science.
Materials science.

Automation of technological processes in materials science and welding.

Competencies acquired by the acquirer:
General competences:
Willingness to use humanitarian, mathematical, natural-scientific and general engineering knowledge in professional activities.
The ability to use the principles of rational use of natural resources and environmental protection in professional activities.
Knowledge and understanding of one's specialty.
Ability and readiness to implement modern technological processes of obtaining, processing materials, technologies for improving properties and restoring products in order to meet their production requirements.
The ability to analyze violations of the established technological process and the reasons for failure of parts and structures.
Special (professional) competences:
The ability to use modern information and communication technologies in professional activities in the field of materials science and materials technology.
Willingness to apply modeling methods when predicting material properties and optimizing technological processes.
Willingness to work on equipment in accordance with the rules of safety, sanitation, fire safety and labor protection regulations.
Knowledge of the basic technologies of manufacturing, processing, testing of materials and products.
The ability to reasonably apply the material for a specific product, taking into account the requirements of manufacturability, economy, environmental friendliness, reliability and durability.

Learning outcomes according to the educational program:
As a result of mastering a real discipline, students should:
To use cost-effective and ecologically clean methods of production and processing of materials, modern equipment that meet the rules of safety, sanitation, fire safety and labor protection regulations.
Form judgments within the specialty, taking into account the latest achievements in the field of materials science.
Have judgments about promising materials and modern technologies of their processing.
Have knowledge and judgment in the field of technological support for the manufacture and processing of materials and products from them.
Have judgments about the rational and economical use of equipment and devices for processing and quality control of materials and products.

Thematic plan

Topic No	Title of topics (LC, LW, PW, SS, InW)	Number of hours
		intramural
1	**LC** –	–
	PW (LW, SS) Introduction. Principles and main tasks 3D modeling. Construction of a simple part.	3
	InW Ways of developing product designs using computer 3D modeling methods.	4
2	**LC** –	–
	PW (LW, SS) The main components of computer modeling. Geometric modeling of the body part from a homogeneous material in the environment of the Fusion 360.	3

	InW Components of CAD and the main provisions of their installation.	5
3	**LC** –	–
	PW (LW, SS) Components of the geometric modeling process: stages, stages, procedures and operations. Drawings of components of machine drives in the environment of the Fusion 360.	3
	InW Types of databases of geometric models of technical objects by materials and their characteristics.	4
4	**LC** –	–
	PW (LW, SS) Unification of design solutions and design procedures. Geometric modeling of machine drive components in the Fusion 360 software environment.	3
	InW External and internal geometric modeling of parts.	5
5	**LC** –	–
	PW (LW, SS) Application of varieties of graphic primitives, their colors, types of lines, screen menu.	3
	InW Provision of the tablet menu and graphical menu.	4
6	**LC** –	–
	PW (LW, SS) Performing geometric modeling of machine elements based on a scanned original.	3
	InW Purpose, functions, capabilities and scope of application of applications as means of engineering machine graphics.	5
7	**LC** –	–
	PW (LW, SS) Construction of 3D models of complex objects in the Fusion 360 system environment. Construction of assemblies in the Fusion 360 program environment.	3
	InW Setting up the user's working environment for building 3D models.	4
8	**LC** –	–
	PW (LW, SS) Purpose and work in CAM-mode. Basic principles of modeling programmable machining on CNC machines.	3
	InW Changing the properties of CAM models. Means of changing properties.	5
9	**LC** –	–
	PW (LW, SS) Modeling in CAM-mode of control programs of milling processing for CNC machines and their visualization.	3
	InW Coding of technological information.	4
10	**LC** –	–
	PW (LW, SS) Modeling in CAM-mode of control programs of drilling processing for CNC machines and their visualization.	3
	InW Visualization of control programs on machine tools equipped with computer control systems.	5
11	**LC** –	–
	PW (LW, SS) (PR, NW) Modeling in CAM-mode of control programs for turning for CNC machines and their visualization.	3
	InW 3D models of control programs for lathes equipped with CNC control systems.	4
12	**LC** –	–
	PW (LW, SS) Application of computer 3D modeling methods for the study of physical and mechanical characteristics of materials.	3
	InW Editing objects in the environment of the Fusion 360 system. Editing and actions on objects.	5

13	**LC** –	–
	PW (LW, SS) Methods of computer 3D modeling for studying the loading of structural elements.	3
	InW Software CAE environments.	4
14	**LC** –	–
	PW (LW, SS) Methods of computer 3D modeling for thermal processes.	3
	InW Graphical user interface for modeling, its components.	5
15	**LC** –	–
	PW (LW, SS) Three-dimensional computer modeling of parts and products of special structure from powder composite materials and reinforced polymers.	3
	InW Graphic output devices.	4
16	**LC** –	–
	PW (LW, SS) 3D modeling for testing the physical and mechanical properties of materials.	3
	InW Application of 3D modeling capabilities for high technologies.	5
Together	**LC**	–
	PW (LW, SS)	48
	InW	72

Individual educational and research task (if available)**:**

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;
3.2) interactive (non-traditional): business and role-playing games, trainings, seminars-discussions, "round table", brainstorming method.

System assessment 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", "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 an argumentative 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:

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

where $K^{nomoч}$ 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 – number of ongoing control measures.
O prices are converted into points according to the calculation scale (table 1).

Table 1 – Conversion of the average score 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": 82% to 89% correct answers;
– "Good": from 74% to 81% of correct answers;
– "Satisfactory": from 67% to 73% of correct answers;
– "Fair enough": 60% to 66% 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 the required one)* :
– on a two- point scale (passed/failed) according to table 2;
– for 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
80–89	**Okay**	**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
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.

Score in points	Evaluation on a national scale		Evaluation according to the ECTS scale	
	examination	test	Rating	Criteria
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 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 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 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 Books: *(literature no later than 10 years old, except for 1 fundamental classic textbook or monograph)*

1. Tekhnolohiia konstruktsiinykh materialiv ta materialoznavstvo: navchalnyi posibnyk / I.P. Hladkyi, V.I. Moshchenok, V.P. Tarabanova, N.O. Lalazarova, D.B. Hlushkova. - Kharkiv: KhNADU, 2014. - 528 s.
2. Systemy avtomatyzovanoho proiektuvannia: konspekt lektsii [Elektronnyi resurs]: navch. posib. dlia stud. spetsialnosti 151 «Avtomatyzatsiia ta komp'iuterno-intehrovani tekhnolohii», spetsializatsii «Komp'iuternointehrovani systemy ta tekhnolohii v pryladobuduvanni» / KPI im. Ihoria Sikorskoho; avtory: K.S. Barandych, O.O. Podolian, M.M. Hladskyi. – Elektronni tekstovi dani (1 fail 3,05 Mbait). – Kyiv: KPI im. Ihoria Sikorskoho, 2021. – 97 s.
3. Podryhalo M.A., Dudukalov Yu.V. Proektuvannia tekhnolohii mashynobudivnoho ta remontnoho vyrobnytstva: [pidruchnyk] / Podryhalo M.A., Dudukalov Yu.V., Polianskyi O.S., Dubinin Ye.O. ta in. – Kh.: KhNADU, 2019. – 318 s.

Additional sources:

1. distance learning course: https://dl2022.khadi-kh.com/course/view.php?id
2. Official website of the company KhNADY [Electronic resource]. – 2023.
3 Positioning http://help.autodesk.com/view/fusion360/ENU/?guid=GUID-509FE7DB8E56-4048-9AE9-22683EF5C07A
4 Sweeping of surfaces https://forums.autodesk.com/t5/fusion-360-russkiy/razvertka-poverhnostey/td-p/6677610
5 Working with 3D models in Fusion 360 https://www.pointcad.ru/novosti/rabota-s-3d-modelyami-v-sisteme-fusion360-%E2%80%93-ot-konczepczii-do-voploshheniya-(chast-1)
6 Standard products in Fusion 360 https://www.pointcad.ru/novosti/ctandartnyie-izdeliya-vo-fusion-360
7 Component libraries (AutoCAD Mechanical Toolset) https://knowledge.autodesk.com/ru/support/autocad-mechanical/learnexplore/caas/CloudHelp/cloudhelp/2019/RUS/AutoCADMechanical/files/GUID-D80CCFCC-BD45-4C2B-9090-2864C5C3055Chtm.html
8 Functionality Autodesk Fusion 360 https://www.pointcad.ru/product/autodesk-fusion-360/funkczional-autodeskfusion-360
9 SolidWorks. URL: https://www.solidworks.com (date of application 01.12.2022).
10 SolidWorks. URL: https://www.softkey.ua/catalog/sapr/solidworks/#detail_text (date of application 01.12.2022).

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