SYLLABUS
educational component
(at the choice of the students)

Designing and manufacturing of parts using new technologies

Subject:	**Designing and manufacturing of parts using new technologies**
Level of higher education:	**First (undergraduate)**
Course page in Moodle:	***https://dl.khadi.kharkov.ua/course/view.php?id=2297***
The scope of education component	**4 credits (120 hours)**
The form of the summary control	**Test**
Consultations:	**on schedule**
Name of the department:	**Machine Components and Theory of Machines and Mechanisms**
Teaching language:	**Ukrainian, English**
Course leader:	**Bohdan Dmytro Ivanovych, Candidate of Technical Sciences, Associate Professor**
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Brief content of the educational component:
The goal is to provide design training in the field of designing parts and assemblies of general-purpose machines using automated design systems, to study methods of calculation and design of typical parts and assemblies of machines and mechanisms based on their functional classification. To familiarize with modern technologies of production and finishing of parts.
Subject: theoretical and practical foundations of designing technical devices based on the use of modern approaches, as well as initial data on the parameters of the technological process for its implementation.

The main tasks of studying the academic discipline are:
- formation of skills in design and construction, organizational, productional and technological activities;
- mastering the theory of calculation and construction, operation of general purpose assamblies and parts;
- study of the general principles of construction and design, construction of algorithms and calculation models of typical mechanical engineering products, taking into account the main performance criteria necessary for assessing the reliability of the industry's operating equipment during operation;
- learning the basics of designing mechanisms and machines, the rational choice of the required type of machine drive and its components;
- acquisition of construction and design skills, which ensure the choice of forms, materials, methods and sizes of creation of typical engineering products;
- studying the general principles of all calculations for typical engineering products.
- familiarization with modern technologies for the production of parts, new materials, their properties and criteria for their rational selection;
- formation of skills for working with devices for volumetric molding;
- familiarization with technologies and materials for finishing parts.

Prerequisites for studying the educational component:
Higher mathematics; Physics, Engineering and computer graphics

Competencies acquired by the acquirer:

General competences:

Ability to abstract thinking, analysis and synthesis.
Ability to apply knowledge in practical situations.
Ability to search, process and analyze information from various sources.
Ability to identify, pose and solve problems.
Ability to work autonomously.
Ability to think critically, generate new ideas, analyze and synthesize holistic knowledge.

Special (professional) competences:

The ability to use knowledge of the basics of construction and calculation of general-purpose components and parts in professional activities.

Ability to use automation tools, modern technological processes, technological equipment and equipment in the process of creation, operation, repair and maintenance of machines and mechanisms, their systems and elements.

The ability to search, process, analyze and generalize information to independently solve problems in the field of devices for volumetric molding.

Learning outcomes:

Be able to learn independently, acquire new knowledge and improve skills in working with modern application software and equipment.

Be able to make calculations, create three-dimensional models and draw up design documentation.

Choose materials, technologies and types of coatings for the production of parts with the necessary characteristics.

Use devices for volumetric molding to obtain workpieces or finished products.

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)	Quantity hours	
		intramural	extramural
1	**LL** Itroduction. Modern trends in the process of development and implementation in the production of assemblies of machine parts.	2	
	PL Types of automated design platforms.	4	
	IW Add-ons in various CAD systems for calculating assemblies of machine parts.	9	
2	**LL** Design of parts from sheet material.	2	
	PL Basics of the technological process of manufacturing parts from sheet material and creating a scan of the part of the device body.	4	
	IW Comparison and scope of application of the three main types of cutting sheet parts, namely laser, plasma and hydroabrasive.	9	
3	**LL** Protective and decorative coatings.	2	
	PL Types of coatings, classification, areas of application.	4	
	IW The cost of applying the main types of coatings.	9	
4	**LL** Production of parts using additive technologies (part I)	2	
	PL Preparation of models for 3D printing, taking into account limitations in manufacturing by various methods.	4	
	IW Creating a case model.	9	
5	**LL** Production of parts using additive technologies (part II).	2	
	PL Preparation of a control program for a 3D printer using application software.	4	
	IW Creating a control program for a specific part.	9	
6	**LL** Mechanical properties of materials in additive manufacturing technologies.	2	
	PL Selection of materials, calculation of the required volume for the manufacture of the part.	4	
	IW Formation of support elements for a three-dimensional model.	9	
7	**LL** Blade processing of parts using CNC machines.	2	
	PL Basics of creating management programs.	4	
	IW Creation of a control program for manufacturing a part by the turning method.	9	
8	**LL** Technical process of obtaining non-metallic products using polymer casting	2	
	PL Selection of materials, calculation of the required volume.	4	
	IW Development of a mold for casting and its elements.	9	
Total	**LL**	16	
	PL	32	
	IW	72	

Teaching methods:

- verbal method (lecture, discussion, etc.);
- practical method (practical classes);
- visual method (the method of illustrations and the method of demonstrations);
- independent work.

Evaluation system and requirements:

Current performance

1 The current success rate 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:

$$K^{current} = \frac{K_1 + K_2 + ... + K_n}{n},$$

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

$K_1, K_2, ..., K_n$ – 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 – Conversion of the average score for the current activity into a multi-point scale

4-point scale	100-points scale	4-point scale	100-points scale	4-point scale	100-points scale	4-point 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
						re-examination	
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 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

The rating assessment of the discipline and its translation into grades on the national scale and the ECTS scale is carried out in accordance with the Regulations on the Evaluation of the Study Results of Higher Education Applicants of the KHNAHU.

Table 3 – 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 on a national scale	
	exam	test	Grade	Criterion
90-100	**Excellent**	**Passed**	**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**		**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 evaluated 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 significant, 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 on a national scale	
	exam	test	Grade	Criterion
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 passed**	**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;

– 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 KHNAHU» (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_0-02.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 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.

Basic literature

1. Geychuk, V. M. Functional design of machines, robots and machines in Autodesk Inventor. Part I [Electronic resource]: study guide for students studying the specialty "Industrial mechanical engineering" / V. M. Geychuk; KPI named after Igor Sikorsky. – Electronic text data (1 file: 13.39 MB). – Kyiv: KPI named after Igor Sikorskyi, 2017. – 394 p. – Title from the screen.
2. Verba, I. I. Study guide "Automated production equipment" "Modern trends in the development of automation systems" for in-depth study of the discipline [Electronic resource]: study guide for students of specialty 131 "Applied mechanics", specialization "Technologies of computer-aided design of machine tools" , robots and machines" / I. I. Verba, O. V. Danylenko, O. V. Samoilenko; KPI named after Igor Sikorsky. – Electronic text data (1 file: 5.65 MB). – Kyiv: KPI named after Igor Sikorskyi, 2020. – 260 p. – Title from the screen.
3. Danylenko, O. V. Study guide "Machine details" "Using modern CAD/CAE systems in the calculations of machine details" for laboratory work in the subject [Electronic resource]: study guide for students studying in specialty 131 "Applied mechanics" " with the specialization "Technologies of computer design of machines, robots and machines", "Instrumental systems of engineering design" and specialty 133 "Industrial mechanical engineering" with the specialization "Metal cutting machines and systems", "Instrumental systems" / O. V. Danylenko, I. I Willow; KPI named after Igor Sikorsky. – Electronic text data (1 file: 2.0 MB). – Kyiv: KPI named after Igor Sikorskyi, 2020. – 53 p. – Title from the screen.
4. Designing the equipment of machine tools, robots and machines [Electronic resource]: a study guide for students studying in specialty 133 "Industrial mechanical engineering" specialization "Computer design of machine tools, robots and machines" / NTUU "KPI named after Igor Sikorsky"; structure. V. P. Prykhodko, O. V. Lytvyn. – Electronic text data (1 file: 22.0 MB). - Kyiv: NTUU "KPI named after Igor Sikorsky", 2018. - 211 p. – Title from the screen.
5. Pukhovskyi, E. S. Progressive processes of material processing [Electronic resource]: a study guide for students studying specialty 131 "Applied mechanics" / E. S. Pukhovskyi; KPI named after Igor Sikorsky. – Electronic text data (1 file: 5.38 MB). – Kyiv: KPI named after Igor Sikorskyi, 2021. – 132 p. – Title from the screen.
6. Voropay A., Yehorov P., Gnatenko G., Povalıayev S., Sharapata A., “Optimization of Models of Machine Parts for 3D Printing” Int. J. of 3D Printing Tech. Dig. Ind., 6(3): 511-520, (2022).

Supporting literature:

1. Distance course: *https://dl2022.khadi-kh.com/course/view.php?id= 2297*
2. Distance course: *https://dl2022.khadi-kh.com/course/view.php?id=3502*
3. Distance course: *https://dl2022.khadi-kh.com/course/view.php?id=3350*
4. Ian Gibson, David Rosen, Brent Stucker. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing. Springer, 2014. https://books.google.com.ua/books?id=OPGbBQAAQBAJ
5. 3D TODAY, “An Overview of High Temperature FDM Plastics for Industrial 3D Printing” [An Overview of High Temperature FDM Plastics for Industrial 3D Printing] [article in Russian], https://3dtoday.ru/blogs/top3dshop/overview-of -high-temperature-fdm- plastics-for-industrial-3d-printing, October 8, 2022.
6. Pascu, NE, Arion, AF, Dobrescu, T., Carutasu, NL “Fused deposition modeling design rules for plastics”, Mat. Plast, Vol. 52, Page 141, 2015.
7. https://3dprint.infomir.eu/uk/aditivne-virobnicztvo

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