Syllabus
educational component of selective component
(reference designation of educational component in eductonal program
(educational program))

Technologies of modern and perspective materials

Course title:	**Technologies of modern and perspective materials**
Level of high education:	**the second (master's)**
Course link in Moodle:	*https://dl2022.khadi-kh.com/course/index.php?categoryid=801*
The volume of educational component:	**3 credits (90 hours)**
Final assessment:	**Test**
Concultations:	**Not provided according the curriculum**
Name of the department:	**Technologies of metals and materials science**
Language of teaching:	**Ukrainian, English**
Course leader:	**Ryzhkov Yurii Volodymyrovych, Ph.D. in Technical Sciences, Associate professor**
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Summary of the educational component:

The aim is formation of students` set of basic knowledge and ideas regarding the formation of the structure and properties of modern functional materials and coatings, mechanisms of manifestation of functional properties, manufacturing technology and application of promising materials.

Subject: Basic ideas about the creation of new functional materials depending on their properties, the ability to optimize, from an economic and technological point of view, the technology of manufacturing functional materials; use new methods and research methods of functional materials.

The main objectives of studying an academic discipline are:

The ability to identify and pose problems in the field of materials science, make effective decisions to solve them, and plan and conduct research in the field of materials science in laboratory and industrial conditions at an appropriate level using modern methods and experimental techniques.

Prerequisites for studying the educational component:

the discipline is studied after
studying the disciplines "Physics", "Materials Science", "Fundamentals of metallography and structural analysis of materials", "Steels and alloys with special properties".

Competencies gained by the applicant:

General competencies:

The ability to generate new ideas and implement them in the form of sound innovative solutions.
The ability to find, process and analyze information from various sources.

The ability and readiness to implement modern technological processes of obtaining and processing materials and technologies for improving properties and restoring products in order to meet their production requirements.

Special (professional) competences:
The ability to perform scientific research, analyze and process the results of natural or model experiments, using regulatory documents, new hypotheses in the field of materials science, information technology, software.
The ability to apply modern methods and experimental techniques in laboratory and production conditions, the ability to use research and testing equipment to solve problems in the field of materials science.
Specialized knowledge of the latest methods and techniques of modeling, development and research of materials.
Knowledge of the main groups of materials and the ability to reasonably select them for specific operating conditions.

Learning outcomes according to the educational program is to:
Use experimental methods of studying structural, physical-mechanical, electrophysical, magnetic, optical and technological properties of materials.
Use new methods and methods of researching materials and their processing processes based on knowledge of the methodology of scientific research and the specifics of the problem to be solved, correctly interpret the results of research and draw conclusions.
Apply the requirements of domestic and international normative documents regarding the formulation and solution of scientific and scientific-technical problems of development, production, testing, certification, disposal of materials, creation and application of effective technologies for the production of products in educational and teaching activities.

Thematic Plan

№ topic	Topics (Lecture (L.), laboratory class (LC), Practicals (P), self-study (SS), self-guided work (SGW)	Number of hours
		ocular
1	L Introduction. Materials with shape memory: prospects for development.	2
	P (LC, SS) Determination of elastic moduli of functional materials.	2
	SGW Processing of information support for each module (topic)	6
2	L General problems of materials with high-temperature shape memory.	2
	P (LC, SS) Determination of residual stresses of the 1st in alloys with shape memory effect.	2
	CP Development of information support for each module (topic)	6
3	L Shape memory effect induced by martensitic transformation at elevated temperatures in known and new metallic materials.	2
	P (LC, SS) Measurement of magnetic characteristics of functional materials.	2
	SGW Processing of information support for each module (topic)	6
4	L Deformation processes of high-temperature alloys with shape memory effect preceding shape recovery.	2
	P (LC, SS) Determination of the amount of residual austenite during martensitic transformation.	2
	SGW Processing of information support for each module (topic)	8
5	L Increase in martensitic deformation due to grinding of the substructure (low-temperature heat treatment of titanium	2

	nickelide).	
	P (LC, SS) Determination of the change in crystallographic orientation during phase transformations.	2
	SGW Processing of information support for each module (topic)	8
6	L Alloys with special properties of thermal expansion. Materials with shape memory effect. Super hard materials.	2
	P (LC, SS) Study of phase stability during martensitic transformation.	2
	SGW Processing of information support for each module (topic)	8
7	L Complications of martensitic transformation crystallography	2
	P (LC, SS) Determination of free energy of austenitic and martensitic phases during martensitic transformation.	2
	SGW Processing of information support for each module (topic)	8
8	L High-entropy alloys with shape memory as an embodiment of directions for improvement pigh-entropy alloys shape memory elements	2
	P (LC, SS) Determination of the level of accumulated deformation in alloys with shape memory effect at constant temperature.	2
	SGW Preparation for the final assessment	8
Together	L	16
	P (LC, SS)	16
	SGW	58

Individual educational and research task (if available): absent

Teaching methods:
1) oral: 1.1 traditional: lectures, explanation, telling etc;
1.2 non-traditinal :electronic option, remote.
2) visual: illustration method, demonstration method
3) practical: 3.1 traditional practical lessons
3.2 no-traditional remote

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", "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 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 literature:

1. Basic literature

1. H.S. Firstov. Functional materials with shape memory: current state and prospects of use, Bulletin of the National Academy of Sciences of Ukraine, 2018, №6, P. 19-34.
2. High-temperature alloys with shape memory / H.S. Firstov.// K. : Scientific thought, 2019. – 200 p.
3. Guo S., Liu C.T. Phase stability in high entropy alloys: Formation of solid-solution phase or amorphous phase. Prog. Nat. Sci.: Mater. Int. 2011. 21(6): 433.
4. Firstov G.S., Kosorukova T.A., Koval Yu.N., Odnosum V.V. High entropy shape memory alloys. Materials Today: Proceedings. 2015. 2: 499.
5. Firstov G.S., Kosorukova T.A., Koval Yu.N., Verhovlyuk P.A. Directions for High-Temperature Shape Memory Alloys' Improvement: Straight Way to High-Entropy Materials. Shape Memory and Superelasticity, 2015. 1: 400.

2 Additional literaure

1. Senkov O.N., Scott J.M., Senkova S.V., Miracle D.B., Woodward C.F. Microstructure and room temperature properties of a high-entropy TaNbHfZrTi alloy. Journal of Alloys and Compounds. 2011. 509: 6043.
2. Lilensten L., Couzinié J.P., Perrière L., Bourgon J., Emery N., Guillot I. New structure in refractory high-entropy alloys. Mater. Lett. 2014. 132: 123.
3. Murty B.S., Yeh J.-W., Ranganathan S. High-Entropy Alloys. (Oxford: Butterworth-Heinemann, 2014).
4. Tsau C.-H. Phase transformation and mechanical behavior of TiFeCoNi alloy during annealing. Mater. Sci. Eng. A. 2009. 501(1): 81.

Developer(s) syllabus of the educational discipline	_____ signature	Yu.V. Ryzhkov name
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