National University of Life and Environmental Sciences of Ukraine
Department of Material Technology and Material Science (MTMS)

"CONFIRMED"
Dean of Design and
Engineering Faculty

Zinoviy RUZHYLO
«____» _____2023

"APPROVED"
at a meeting of the department MTMS

Protocol № 15 of "10"05 2023
Head of Department
Evgeny AFTANDILYANTS

"REVIEWED "
Program Coordinator
133 "Sectoral mechanical engineering"
Volodymyr BULGAKOV

PROGRAM OF THE COURSE
" Material Science "

Speciality 133 "Sectoral mechanical engineering"

Educational program Sectoral mechanical engineering

Faculty of Design and Engineering

Developer: d. t. s., professor – Evgeny Aftandiliants

Kyiv – 2023

1. Description of the discipline
Material Science
(title)

Areas of knowledge, direction of training, speciality, education and qualification level		
For ED	Bachelor	
Knowledge area	13 "Mechanical engineering "	
Speciality	133 "Sectoral mechanical engineering"	
Specialization	-	
Discipline characterization		
Type	Obligatory	
Total number of hours	150	
Number of credits ECTS	5	
Number of thematic modules	6	
Form of control	*test /examination*	
Indicators of the discipline for daily and distance learning		
	daily learning	distance learning
Year of study (course)	2	1/2
Semester	3/4	2/3
Lectures	*30/15* hours.	*2/4* hours.
Practical, seminar classes	-	-
Laboratory lesson	*30/15* hours.	*2/6* hours.
Independent study	*30/30* hours.	*-/232* hours.
Individual work	- hours.	- hours.
Number of weekly classroom hours for daily learning	*4/2* hours.	*13/14* hours.

2. The purpose and objectives of the course

Purpose is skills of Materials Science and laying the basis for the study subjects: "Machine parts", "Hoisting machinery", "Tractors and cars", "Agricultural and meliorative machines", "The safety and repair of machines."

Objectives:

- Study methods of obtaining metals and alloys;
- Study of the structure, properties and destination of metals and alloys;
- Studying the basic theory of heat treatment of carbon and alloy steels, their technology heat and chemical-heat treatment, as well as specific details and working of agricultural machines;
- The study of the structure, properties and appointment of non-metallic construction materials.

A result of studying of discipline the student should:

know:

the main connections between the composition, structure and properties of metals and alloys, as well as patterns and changes in these properties under thermal, chemical or mechanical stress.

be able to:

based on knowledge of the working conditions to work of the machine parts to select of the construction material for their production, type of hardening ore softening treatment for obtaining of the certain the properties of parts and billets.

Competencies of educational program:

1) *Integral competence:* The ability to solve complex specialized tasks and solve practical problems in the field of mechanical engineering using the theories and methods of modern science based on a systems approach and taking into account the complexity and uncertainty of the operating conditions of technological systems.

2) *General competencies:*

GC2. Ability to apply knowledge in practical situations.

GC5. Ability to generate new ideas (creativity).

GC8. The ability to act socially responsibly and consciously.

GC13. The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and technologies, to use various types and forms of motor activity for active recreation and leading a healthy lifestyle.

3) *Special (professional) competences of the specialty (SC)*:

PC6. The ability to evaluate the technical and economic efficiency of typical systems and their components based on the application of analytical methods, analysis of analogues and the use of available data.

PC9. The ability to carry out commercial and economic activities in the field of mechanical engineering.

Programmatic learning results

LR4. Carry out engineering calculations to solve complex problems and practical problems in industrial mechanical engineering.

LR6. Search for the necessary scientific and technical information in available sources, in particular, in a foreign language, analyze and evaluate it.

LR9. Choose and apply the necessary equipment, tools and methods.

LR12. Apply means of technical control to evaluate the parameters of objects and processes in industrial mechanical engineering.

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3. The program and structure of discipline for

- full term of daily and distance learning

Title of thematic modules and themes	Hour numbers												
	Daily learning							Distance learning					
	Weeks	Total	Including					Total	Including				
			l	P	lab	ind	i.s.		l	p	lab	ind	i.s.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
The thematic module 1. Metal science													
Theme 1. The theory of alloys	1-2	8	4	-	4	-	2	22	2	-	-	-	20
Theme 2. Carbon steels and cast irons	3-5	12	6	-	6	-	3	22	-	-	2	-	20

Total for thematic module 1	25		10	-	10	-	5	44	2	-	2	-	40
The thematic module 2. Bases of heat treatment of metals and alloys													
Theme 1. The theory of heat treatment	6-8	12	6	-	6	-	2	22	2	-	-	-	20
Theme 2. Technology of heat treatment	9-11	12	6	-	6	-	3	22	-	-	2	-	20
Total for thematic module 2	29		12	-	12	-	5	44	2	-	2	-	40
The thematic module 3. Alloyed steels and alloys													
Theme 1. The alloying theory	12-13	8	4	-	4	-	2	22	2	-	-	-	20
Theme 2. Classification of alloy steels, marking and their use in agriculture	14-15	8	4	-	4	-	3	22	-	-	2	-	20
Total for thematic module 3	21		8	-	8	-	5	44	2	-	2	-	40
The thematic module 4. Steels and alloys with special properties													
Theme 1. Corrosion and heat resistant steels and magnetic alloys.	1-2	4	2	-	2	-	2	20	-	-	-	-	20
Theme 2. Amorphous, bimetallic and composite materials and materials with shape memory	3-5	4	2	-	2	-	3	20	-	-	-	-	20
Total for thematic module 4	13		4	-	4	-	5	40	-	-	-	-	40
The thematic module 5. Non-ferrous metals and alloys													
Theme 1. Copper, aluminum, titanium, magnesium and their alloys	6-8	8	4	-	4	-	2	20	-	-	-	-	20
Theme 2. Zinc, lead. Solders. Antifriction alloys	9-11	6	3	-	3	-	3	20	-	-	2	-	20
Total for thematic module 5	19		7	-	7	-	5	40	-	-	2	-	40
The thematic module 6. Nonmetallic construction materials													
Theme 1. Polymers and plastics. Rubber. Glue materials. Inorganic glass.	12-13	4	2	-	2	-	2	16	-	-	-	-	16
Theme 2. Paints and insulating materials. Wood.	14-15	4	2	-	2	-	2	16	-	-	-	-	16

Total for thematic module 6	12	4	-	4	-	4	40	-	-	-	-	40
Total of hours	119	45	-	45	-	29	246	6	-	8	-	232

4. Lecture themes

№	Theme title	Hour numbers
	3 semester	
1	The purpose and objectives of the course. (Classification. Atomic crystal structure of metals. Defects in the crystal structure of metals).	2
2	Phase transformations of metals and alloys. (The concept of alloy crystallization and modification. The temperature crystallization. The phenomenon of supercooling. The concept of anisotropy. Allotropic transformation).	2
3	Basic theory of alloys. (Definition of "Alloy", "Component", "Phase". “Solid solutions”. Regularities of cooling metals and alloys).	2
4	State diagrams of binary alloys. (Main types of phase diagrams of two-component alloys. Determination of the phase diagram of alloys. The conditions building. State diagrams alloys of the type I. State diagrams alloys of the type II. State diagrams alloys of the type III. State diagrams alloys of the type IV. Kournakov rule. Section rule.)	2
5	Diagram of the iron - cementite alloys. (Temperature curve heating and cooling of pure iron. Identification of all lines of iron - cementite diagram. Characteristics of structural components of iron-carbon alloys. Definitions of "eutectic" and " eutectoid")	2
6	Carbon steels. Classification and application. (Structure hypoeutectoid, eutectoid and hypereutectoid steels. Labelling and application of carbon steels).	2
7	Cast irons, classification, application. (Concept and classification of cast irons. The impurity influence on the structure and properties of cast irons. Method, structure, labeling and application of gray, ductile and high strength irons.)	2
8	Theory of heat treatment. (Transformation of pearlite - carbide structure in austenite during heating. Temperature influence on the grain size of austenite during heating. The concept of inheritance structure. The influence of grain size on the properties of steel. Methods for determining grain size).	2
9	The basic structure and transformation during heat treatment of steels. (Pearlitic transformation. The mechanical properties of steels with structures of perlite, sorbite, troostite (fine pearlite). Martensitic transformation. The nature of the mechanism and kinetics of transformation. Martensite properties. The Martensite transformation at heating.)	2
10	Diagram of austenite isothermal disintegration. (General characteristics of austenite transformation at supercooling. Construction diagram of isothermal transformation of austenite to 0.8% carbon steel. The transformation of austenite under continuous cooling.)	2

11	The heat treatment technology of carbon steels. (Annealing, normalization, quenching, tempering and aging of steels).	2
12	Chemical heat treatment of steels. (Basic processes occurring at the chemical and heat treatment. cementation, nitriding)	2
13	Bases alloying steels. (The influence of alloying elements on the properties of steel. Features heat treatment of alloyed steels. Isothermal transformation of austenite in alloy steels. The influence of temperature on the properties of quenching steel alloy).	2
14	Classification and labeling of alloy steels. (Determination of class alloyed steel. Labelling structural and tool alloy steel).	
15	Constructional alloyed steels. Spring and ball bearing steels. Tool alloyed steels.	
4 semester		
1	Steels and alloys with special properties. (High-strength and wear-resistant steel. Corrosion-resistant and heat-resistant steel. Magnetic steel and alloys. Alloys with high electrical resistance. Steels with a given temperature coefficient of linear expansion).	2
2	Foreign labeling of alloy steels	2
3	Copper, aluminum and their alloys	2
4	Titanium, magnesium and their alloys. Bearing alloys	2
5	Amorphous materials and materials with shape memory	2
6	Composite and bimetallic materials	2
7	Polymers and plastics. Rubber. Glue materials. Inorganic glass.	2
8	Paints and insulating materials. Wood.	1

5. Laboratory work themes

№	Theme title	Hour numbers
3 semester		
1	Macrostructural analysis of metals and alloys	2
2	Microstructural analysis of metals and alloys.	2
3	The study diagrams of binary alloys	2
4	The thermal method of analysis of metals and alloys. Construction of diagrams of tin-zinc alloys.	2
5	The analysis of state diagram of iron-carbon alloys	2
6	Study of the microstructure of carbon steels at equilibrium state	2
7	Study of microstructure of cast irons	2
8	Structural changes in the carbon steel at heating.	2
9	Annealing and normalization of carbon steels. Study of microstructure and hardness changes	2
10	Quenching of carbon steels	2
11	Tempering of quenching steels	2
12	Determination of critical temperatures of steels by method of	2

	test quenchings	
13	Determination of carbon steel microstructure in a nonequilibrium state	2
14	Surface hardening steels by high frequency currents	2
15	Chemical heat treatment of steels	2
4 semester		
1	Definition hardenability steels	2
2	Study of microstructure of alloy steels	2
3	Development of technological process of the heat treatment of parts of agricultural machines	2
4	Study of the microstructure of copper alloys	2
5	Study of the microstructure of aluminum alloys	2
6	Study of microstructure babbits	2
7	Composite and bimetallic materials	2
8	Materials with shape memory	1

6. Test questions and test sets for determine of the level assimilation of knowledge by students.

1. Ferrous metals are differentiated into
2. Non-ferrous metals are subdivided
3. Body-centered cubic lattice
4. Face-centered cubic lattice
5. The main parameters of the crystal lattices
6. Defects in the crystal structure
7. What is alloy, system, component, phase?
8. The mechanical mixture
9. Chemical compounds
10. Solid solutions
11. State (phase, equilibrium) diagram of alloys
12. Mechanical properties
13. Toughness
14. Anisotropy and isotropy
15. Carbon, manganese, silicon, sulphur and phosphorus in steel
16. The classification of carbon steels
17. Structure of hypoeutectoid steel
18. Structure of eutectoid steel
19. Structure of hypereutectoid steel
20. Plain carbon steel classification according with quality
21. Ordinary plain carbon steels
22. Quality plain carbon steels
23. High quality carbon steels
24. Carbon steel classification according with the forming methods of shape and size
25. Carbon steel classification according with application
26. Carbon tool steels

27.Free-cutting (automatic) steels
28.Carbon boiler steels
29.SAE - AISI system (USA)
30.Composition and destination of USA carbon steels
31.Material science is …
32.Material science consists of the following parts …
33.Metals is …
34.Ferrous metals are …
35.Non-ferrous metals are
36.Amorphous materials are
37.Crystalline materials are characterized
38.Elementary crystal lattice called
39.Ionic bond
40.Covalent bond
41.Metal bond
42.Structural imperfections of polycrystals
43.Polymorphic (allotropic) transformations
44.Polymorphic transformation of iron
45.DIN is marking of carbon steels in …
46.JIS is marking of carbon steels in…
47.BS is marking of carbon steels in…
48.AFNOR is marking of carbon steels in…
49.UNI is marking of carbon steels in…
50.SS14 is marking of carbon steels in…
51.SAE - AISI system was developed in …
52.Steel quality is determinated by quantity of …
53.Ordinary plain carbon steels content …
54.Quality plain carbon steels content…
55.High quality carbon steels content…
56.Ordinary plain carbon steels are marked by…
57.Quality steels are marked by…
58.High quality steels have …
59.Which is hardened layer color?
60.Macrostructural analysis carry out on …….
61.Etching liquid solutions content ……..
62.Segregation is ……..
63.Macro-analysis is ……
64.Etching of samples for laboratory work happening by …..
65.Preferred microsection area is …
66.Etching liquid solutions content…..
67.Magnification is set by combination of the…….
68.Microstructural analysis is ……
69.What is ferrite?
70.What is the austenite?
71.What is cementite?

72. What is the pearlite?
73. What is ledeburite?
74. Hardness is …..
75. Brinell hardness is determined ….
76. Rockwell hardness is determined…..
77. Shore hardness is defined…
78. Poldi hardness is determined …..

7. Education methods.

1) Verbal:
   -Lectures;
2) Visual:
   -Slides, video, visual material (perts, charts, stands).
3) Practical:
   - Laboratory work;
   - Training and factory practices;
   - Independent work.

8. Forms control.

- control work;
- module control work;
- test;
- examination.

9. Distribution points that receive students. The student evaluation done in accordance with the provision «Про екзамени та заліки у НУБіП України» від 26.04.2023 р. протокол № 10 з табл. 1.

EVALUATION POLICY

Deadline and retake policy:	The student must submit the work within the time specified by the teacher. Works that are submitted in violation of deadlines without good reason are evaluated at a lower grade. Rearrangement of modules takes place with the permission of the lecturer if there are good reasons (for example, hospital).
Academic Integrity Policy:	Write-offs during tests and exams are prohibited (including the use of mobile devices). Course papers, abstracts must have correct text references to the literature used
Visiting policy:	The student is obliged to attend classes of all kinds every day in accordance with the established schedule, not to be late, to have the appropriate appearance. For objective reasons (for example, illness, international internship) training can take place individually (in online form in consultation with the dean of the faculty)

STUDENT EVALUATION SCALE

Student rating, points	**Evaluation results on national exam tests**	
	Exams	**tests**
90-100	Excellent	Accepted
74-89	Good	
60-73	Satisfactory	
0-59	Unsatisfactorily	Not accepted

The student rating (listener) of the discipline $\mathbf{R_{ДИС}}$ (up to 100 points) to determine as sum rating received at attestation $\mathbf{R_{AT}}$ (up to 30 points) and the student (listener) rating for educational work $\mathbf{R_{НР}}$ (up to 70 points):

10. Methodical provision

- Textbooks and manuals;
- Guidelineses for laboratory works;
- Stands, posters;
- Equipment and various device.

11. Recommended Literature

- Main:

1. Афтанділянц Є.Г., Зазимко О.В., Лопатько К.Г. Матеріалознавство: Підручник (Гриф надано Міністерством освіти і науки, молоді та спорту України, лист №1/11-18055 від 20 листопада 2012 р.). Херсон, Видавець Грінь Д.С., 2013.- с 612.
2. Практикум з матеріалознавства. Навчальний посібник. (гриф МОН (лист № 1/11-4472 від 27.02.2013 р.))/ Котречко О. О. Зазимко, К.Г. Лопатько, Є.Г. Афтанділянц, Гнилоскуренко В. В.// Херсон: Олді Плюс, 2013.-с. 500.
3. Опальчук А.С., Афтанділянц Є.Г., Роговський Л.Л., Семеновський О.Є., Клендій М.Б., Біловод О.І., Дудніков І.А., Матеріалознавство і технологія конструкційних матеріалів: підручник для вищих навчальних закладів III-IV ступенів акредитації; за ред. А.С. Опальчука і О.Є. Семеновського. – Ніжин: Видавець ПП. Лисенко М.М., 2013. – 752 с.
4. Попович В., Голубець В., Технологія конструкційних матеріалів і матеріалознавство: Навчальний посібник для вищих навчальних закладів: У 2-х кн. Книга II. – Суми: ВТД «Університетська книга», 2002. – 260 с.
5. Дриц М.Е., Москалев М.А., Технология конструкционных материалов и материаловедение: Учеб. для вузов. – М.: Высш. шк., 1990. – 447 с.

– ancillary:

1. Афтанділянц Є.Г., Зазимко О. В., Лопатько К.Г., Технологія конструкційних матеріалів і матеріалознавство. Курс лекцій. Частина 1. Металургія. Київ, НАУ, 2005.- с.115.
2. Хільчевський В.В. та ін., Матеріалознавство і технологія конструкційних матеріалів, К: Либідь, 2002, 326с.
3. Бялік О.М., Металознавство, К: Політехніка, 2002, 383с.

- Інтернет джерела:

1. Матеріалознавство і технологія металів. http://univer.nuczu.edu.ua/tmp_metod/924/MZTM_KONSP_LEK.pdf
2. Особливості хіміко-термічної обробки металів і сплавів. https://fizmat.7mile.net/materialoznavstvo/3_4_2-himiko-termichna-obrobka.html 3. Класифікація та обладнання нагрівальних печей. https://fizmat.7mile.net/materialoznavstvo/3_3_5-nagrivalni-pechi.html 4. Термічна обробка виробів із сталі. https://www.youtube.com/watch?v=8UvkV92z2fI
5. Термічна обробка і структури. https://www.youtube.com/watch?v=7mpAt7h317c

12. Information Resources

1. Reference book.
2. Atlases.
3. Internet library.
4. Magazines.