

The National University of Life and Environmental Sciences of Ukraine

Faculty of Design and Engineering

Department of Material Technology and Material Science (MTMS)

APPROVE:

Dean of Design and
Engineering Faculty



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2020

REVIEWED AND CONSIDERED
at a meeting of the MTMS department

Protocol № 16 of "19" 05 2020

Chief of Department



Aftandiliants

WORK PROGRAM OF THE EDUCATIONAL DISCIPLINE

"Material Science"

For ED "Bachelor"

Knowledge area 13 "Mechanical engineering "

Speciality 133 "Sectoral mechanical engineering"

Faculty of Design and Engineering

Developer: Aftandiliants I., Chief of Department, professor.

Kiev – 2020

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	240	
Number of credits ECTS	6	
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	10/19 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 or softening treatment for obtaining of the certain the properties of parts and billets.

acquisition of competencies:

general competencies (GC):

professional (special) competencies (PC): The discipline lays the knowledge base of students of theoretical material in material science necessary in engineering, as a means of educating future industrial engineers skills in scientific generalizations, the ability to use basic knowledge in solving problems in engineering. The discipline lays the knowledge base for students for further study of a number of professional disciplines of technical and technological direction.

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	1-2	4	2	-	2	-	2	20	-	-	-	-	20

alloys.													
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.	2

	State diagrams alloys of the type IV. Kournakov rule. Section rule.)	
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 test quenchings	2
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 determined 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 27.12.2020 р. протокол № 5 з табл. 1.

EVALUATION POLICY

<i>Deadline and retake policy:</i>	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).
<i>Academic Integrity Policy:</i>	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
<i>Visiting policy:</i>	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 $R_{\text{ДНС}}$ (up to 100 points) to determine as sum rating received at attestation $R_{\text{АТ}}$ (up to 30 points) and the student (listener) rating for educational work R_{HP} (up to 70 points):

10. Methodical provision

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

11. Recommended Literature

- Main:

1. Афтанділянц Є.Г., Зазимко О. В., Лопатько К.Г. Технологія конструкційних матеріалів і матеріалознавство. Частина I (А-О). Російсько – англійсько – український термінологічний словник. К.: Вид. Центр НАУ, 2005. - 346 с.
2. Афтанділянц Є.Г., Зазимко О. В., Лопатько К.Г. Технологія конструкційних матеріалів і матеріалознавство. Частина II (П-Я). Російсько – англійсько – український термінологічний словник. К.: Вид. Центр НАУ, 2005. - 282 с.
3. Афтанділянц Є.Г., Зазимко О. В., Лопатько К.Г. Технологія конструкційних матеріалів і матеріалознавство. Курс лекцій. Частина II. Металознавство. Київ, НАУ, 2010.- с.356.
4. 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.
5. 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, Гнилокурченко В. В.// Херсон: Олді Плюс, 2013.-с. 500.
6. Матеріалознавство і технологія конструкційних матеріалів: Підручник (Гриф надано Міністерством освіти і науки України, лист №1/11-9794 від 10.06.2013р.)/Опальчук А.С., Афтанділянц Є.Г., Роговський Л.Л., Семеновський О.Є //Ніжин, ПП Лисенко М.М, 2013.- с 752.

– ancillary:

1. Опальчук А.С., Котречко О.О., Роговський Л.Л. Лабораторний практикум з технології конструкційних матеріалів і матеріалознавства. Навч. посібник/ За ред. А.С. Опальчука. – К.: Вища освіта, 2006.- 287 с.: іл.
2. Сологуб М.А. “Технологія контрукційних матеріалів”, К:Вища школа, 2002, 373с.
3. Хільчевський В.В. та ін. “Матеріалознавство і технологія конструкційних матеріалів”, К:Либідь, 2002, 326с.
4. Попович В. Технологія конструкційних матеріалів і матеріалознавство. Книга I. Львів. 2000.-с.264.
5. Гуляев А.П. „Металознавство”, 1985 р.
6. Усова Л.Ф. „Технологія металів та матеріалознавство”, 1987 р.

12. Information Resources

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