NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Material Technology and Material Science (MTMS)

APPROVED

Faculty of Design and Engineering
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CURRICULUM OF ACADEMIC DISCIPLINE

Material Science

Field of knowledge 13 " Mechanical engineering "
Speciality 133 "Sectoral mechanical engineering"
Academic program Sectoral mechanical engineering
Faculty of Design and Engineering

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Description of the academic discipline
“Material Science”

"Materials science" is a comprehensive discipline that contains basic information about the methods of obtaining materials and methods of their physicochemical and mechanical processing in order to give them appropriate properties and shape.

Academic degree, specialty, academic programme		
Academic degree	*Bachelor's*	
Speciality	G13 "Sectoral mechanical engineering"	
Academic program	Sectoral mechanical engineering	
Characteristics of the discipline		
Type	Obligatory	
Total number of hours	180	
Number of credits ECTS	6	
Number of thematic modules	4	
Course project (work) (if any)	-	
Form of assessment	*Exam* *Credit*	
Indicators of the discipline for full-time and part-time forms of university study		
	Full-time	Part-time
Year of study (course)	2	1
Semester	3	2
Lectures	*45* hr.	*12* hr.
Practical, seminar classes	-	-
Laboratory classes	*45* hr.	*12* hr.
Self-study	*90* hr.	*90* hr.
Individual assignments	-	-
Number of hours per week for full-time students	*6* hr.	*24* hr.

Aim, objectives, competences and expected learning outcomes of the discipline

Aim of the discipline 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 of studying the discipline is to study:

- the methods of obtaining metals and alloys;
- the structure, properties and destination of metals and alloys;
- 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 structure, properties and appointment of non-metallic construction materials.

Acquisition of competencies:

- Integral competence (IC):

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.

General competencies (GC):

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.

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

SC6. 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.

SC9. The ability to carry out commercial and economic activities in the field of mechanical engineering.

Expected learning outcomes (ELO):

ELO04. Carry out engineering calculations to solve complex problems and practical problems in industrial mechanical engineering.

ELO06. Search for the necessary scientific and technical information in available sources, in particular, in a foreign language, analyze and evaluate it.

ELO09. Choose and apply the necessary equipment, tools and methods.

ELO12. Apply means of technical control to evaluate the parameters of objects and processes in industrial mechanical engineering.

2. The program and structure of the discipline for

– full-time (part-time) form of study;
– reduced full-time (part-time) form of study.

Modules and topics	**Number of hours**												
	Full-time							**Part-time**					
	Weeks	Total	Including					Total	Including				
			l	p	lab	ind	s.st		l	p	lab	ind	s.st
1	2	3	4	5	6	7	8	9	10	11	12	13	14
The module 1. **Metal science**													
Topic 1. The theory of alloys	1-2	23	6	-	6	-	11						
Topic 2. Carbon steels and cast irons	3-4	22	6	-	6	-	12						
Total for module 1	45		12	-	12	-	23						
The module 2. **Bases of heat treatment of metals and alloys**													
Topic 1. The theory of heat treatment	5-6	23	6	-	6	-	11						
Topic 2. Technology of heat treatment	7-8	22	6	-	6	-	11						
Total for module 2	45		12	-	12	-	22						
The module 3. **Alloyed steels and alloys**													
Topic 1. The alloying theory	9-10	22	6	-	6	-	11						
Topic 2. Classification of alloy steels, marking and their use in agriculture	11-12	23	6	-	6	-	12						
Total for module 3	45		12	-	12	-	23						
The module 4. **Steels and alloys with special properties**													

Topic 1. Corrosion and heat resistant steels and magnetic alloys. Topic 2. Copper, aluminum, titanium, magnesium and their alloys	13-14	22	6	-	6	-	10						
Topic 3. Powder materials technology and superhard alloys Topic 4. Polymers and plastics. Rubber. Adhesive materials. Inorganic glass.	15-16	23	6	-	6	-	12						
Total for module 4	45		8	-	12	-	22						
Total hours	180		45	-	45	-	90						

3. Lecture topics

№	Topic title	Hours
1	Atomic-crystalline structure of metals. Theory of alloys	6
2	Carbon steels and cast irons	6
3	Theory of TO	6
4	Technology of heat treatment of steel	6
5	Theory of alloying	6
6	Classification of alloyed steels, marking and their use in mechanical engineering	4
7	Copper, aluminum, titanium, magnesium and alloys based on them	2
8	Corrosion-resistant, heat-resistant and magnetic steels and alloys.	2
9	Technology of powder materials and superhard alloys	2
10	Polymers and plastics. Rubber. Adhesive materials. Inorganic glass.	2

4. Topics of laboratory classes

№	Topic title	Hours
1	Macrostructural analysis of metals and alloys	2
2	Microstructural analysis of metals and alloys	2
3	Thermal method of analysis of metals and alloys. Construction of phase diagram of tin-zinc alloys. Study of phase diagrams of binary alloys	4
4	Analysis of phase diagram of iron-carbon alloys	4
5	Study of microstructure of carbon steels in equilibrium	2
6	Study of microstructure of cast irons	2

7	Annealing and normalizing of carbon steels. Study of microstructure and changes in hardness	4
8	Quenching of carbon steels and tempering of hardened steels. Determination of hardenability of steels	4
9	Surface hardening of steels by high-frequency currents. Chemical-thermal treatment of steels	4
10	Development of technological process of heat treatment of agricultural machinery parts	6
11	Classification and marking of alloyed steels	2
12	Alloying systems and features of marking of foreign structural steels.	2
13	Study of the microstructure of alloys based on copper and aluminum	2
14	Chemical composition and labeling of superhard materials	2
15	Structure and properties of plastics and other non-metallic structural materials	2

5. Topics for self-study

№	Topic title	Number of hours
1	Aggregate state of matter. Triple transformation point	6
2	Purpose of cast iron	4
3	Purpose of steel	4
4	Source materials for producing cast iron.	6
5	Methods for obtaining high-quality steel	4
6	Main processes for obtaining aluminum	6
7	Polymorphic transformation in iron.	4
8	Temperatures and transformations in pure iron?	4
9	Chemical composition and structure of hypoeutectoid and hypereutectoid steels?	4
10	Foreign marking systems for alloyed steels	6
11	Main types of machine-building cast irons	4
12	Basic technology and operations of heat treatment of steel	6
13	Technology of high-frequency currents. Parameters that affect the depth of the hardened layer when using microwaves?	6
14	Types of tempering used for heat treatment of tools	4
15	Industrial aluminum alloys and their classification	6
16	Industrial use of titanium alloys	6
17	Technological process for obtaining powder materials.	6
18	Properties and areas of use of non-metallic structural materials	4

5. Tools for assessing expected learning outcomes:

- exam;
- credit;
- module tests;
- presentation of laboratory works

6. Teaching methods.

1) Verbal:
   -lectures;
2) Visual:
   -slides, video, visual material (perts, charts, stands).
3) Practical:
   - laboratory work;
   - training and factory practices;
   - self-study.

7. Assessment methods

- exam;
- credit;
- module tests;
- control works;
- presentation of laboratory works.

8. Assessment of learning outcomes

The assessment of students' knowledge and skills is conducted by means of a 100-point scale and is converted into national grades according to Table 1 of the current *Exam and Credit Regulations at NULES of Ukraine*

8.1. Distribution of points by types of educational activities

Type of learning activity	Learning outcomes	Assessment
Module 1. Metal science		
Lecture 1	Know the types of crystal lattices and the atomic-crystalline structure of metals; Know the iron-carbon diagram and the main types of component compounds; Be able to analyze phase diagrams of alloys; Be able to decipher the grades of cast iron and steel	-
Laboratory work 1 Laboratory work 2. Laboratory work 3.		**20**
Lecture 2		-
Laboratory work 4. Laboratory work 5. Laboratory work 6.		**20**
Self study 1		**10**
		-
		20
Modular test work 1.		**30**
Total by module 1		**100**
Module 2. Heat treatment of steel		
Lecture 3	Know the modes and technologies of heat treatment; Be able to choose a given	-
Laboratory work 7. Laboratory work 8.		**20**
Self study 2		**5**

Lecture 4	mode of heat treatment. Be able to choose a given material in accordance with the operating conditions of the parts.	-
Laboratory work 9. Laboratory work 10.		**20**
Self study 3		-
Modular test work 2.		**20**
		5
		30
Total by module 2		**100**
Module 3. Alloy steels and alloys		
Lecture 5	Know the marking system of domestic and foreign grades of alloyed steels; Know the purpose of alloying elements in the alloying system; Be able to choose a suitable material that will satisfy technological and operational properties; Be able to decipher alloyed grades of steels	-
Laboratory work 11.		**15**
Self study 4		**5**
Lecture 6		-
Laboratory work 12.		**20**
Self study 3		-
Modular test work 3.		**30**
Total by module 3		**100**
Module 4. Non-ferrous metals and alloys and powder materials		
Lecture 7	Know the principles and systems of alloying non-ferrous metals and alloys, Know the technological operations for obtaining powder materials; Know the main non-metallic structural materials and their areas of use; Be able to decipher the grades of non-ferrous alloys based on copper, aluminum and titanium; Be able to conduct a technological assessment of the use of non-metallic materials in mechanical engineering.	-
Laboratory work 13.		**25**
Lecture 8		-
Laboratory work 14.		**25**
Lecture 9		-
Laboratory work 15.		**20**
Lecture 10		-
Self study 4		-
Modular test work 4.		**30**
Total by module 4		**100**
Academic work		**70**
Exam		**30**
Total for 3 semester		**100**

8.2. Distribution points that receive by students.

Student rating, points	National grading of exams and credits	
	exams	credits
90-100	excellent	pass
74-89	good	
60-73	satisfactory	
0-59	unsatisfactorily	fail

8.3. EVALUATION POLICY

Deadline and resubmission policy:	The student must submit the work within the deadlines set by the teacher. Works submitted after the deadlines without good reason are evaluated with a lower grade. Re-siting of modules is carried out with the permission of the lecturer if there are good reasons (for example, illness).
Academic Integrity Policy:	Cheating during tests and exams is prohibited (including using mobile devices). Coursework, essays must have correct text references to the literature used
Attendance Policy:	The student is obliged to attend all classes every day according to the established schedule, not to be late, to have an appropriate appearance. For objective reasons (for example, illness, international internship) training can take place individually (in online form in agreement with the dean of the faculty)

9. Teaching and learning aids

– e-learning course of the discipline «Material Science» (https://nubip.edu.ua/sites/default/files/u374/2_z_eng_robocha_programa_materialoznavstvo_2023_0.pdf)
- lectures and presentations (in electronic form);
- textbooks and manuals;
- guidelines for studying a discipline by full-time and part-time students;
- stands, posters;
- equipment and various device.

10. Recommended sources of information

1. Aftandiliants Y., Stepanechko O., Zazymko O. Material Science: Textbook. Київ, НУБІП України, 2022.- с. 528.
2. 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.
3. 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.
4. 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.
5. Попович В., Голубець В., Технологія конструкційних матеріалів і матеріалознавство: Навчальний посібник для вищих навчальних закладів: У 2-х кн. Книга ІІ. – Суми: ВТД «Університетська книга», 2002. – 260 с.
6. Афтанділянц Є.Г., Зазимко О. В., Лопатько К.Г., Технологія конструкційних матеріалів і матеріалознавство. Курс лекцій. Частина 1. Металургія. Київ, НАУ, 2005.- с.115.
7. Хільчевський В.В. та ін., Матеріалознавство і технологія конструкційних матеріалів, К: Либідь, 2002, 326с.
8. Бялік О.М., Металознавство, К: Політехніка, 2002, 383с.
9. Матеріалознавство і технологія металів. http://univer.nuczu.edu.ua/tmp_metod/924/MZTM_KONSP_LEK.pdf
10. Особливості хіміко-термічної обробки металів і сплавів. https://fizmat.7mile.net/materialoznavstvo/3_4_2-himiko-termichna-obrobka.html
11. 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
12. Термічна обробка і структури. https://www.youtube.com/watch?v=7mpAt7h317c