MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION

Federal State Autonomous Education “Ural Federal University named after the first President of Russia B.N. Yeltsin”

Institute of New Materials and Technologies

Signed and Approved

Vice-rector for Research

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V.V. Kruzhaev

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COURSE PROGRAM

**THEORETICAL BASIS OF THE CREATION OF NEW MATERIALS AND ADVANCED TECHNOLOGIES**

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| **The list of information about the work program of the discipline** | **Credentials** |
| **Educational program**  Materials Technology (by industries) (05.16.09) | **Code of EP** 22.06.01  **Curriculum** № 6746 (version 3) |
| **Direction**  Materials technology | **Code of direction and level of preparation** 22.06.01 |
| **Level of preparation**  Training of highly qualified personnel |
| **FSES** | **Details of the order of the Ministry of Education and Science of the Russian Federation on the approval of the FSES:** № 888 of July 30, 2014, as amended on April 30, 2015 |

**Ekaterinburg**

**2018**

**1. GENERAL CHARACTERISTICS OF THE DISCIPLINE**

**The theoretical basis of the creation of new materials and advanced technologies**

**1.1. Annotation of the content of the discipline**

The discipline aims to study advanced materials of the new generation, technologies for their production, structure, properties and fields of application of modern materials**.**

**1.2. The language of the implementation of the discipline is Russian.**

**1.3. Planned learning outcomes of the discipline**

The result of preparation in the framework of the discipline is the formation of the following competencies:

- the ability to critically analyze and evaluate modern scientific achievements, to generate new ideas in solving research and practical problems, including in interdisciplinary areas (UC-1);

- the ability to design and carry out comprehensive research, including interdisciplinary, based on a holistic system of scientific worldview using knowledge in the field of history and philosophy of science (UC-2);

- the readiness to participate in the work of Russian and international research teams to deal with scientific and scientific-educational issues (UC-3);

- the readiness to use modern methods and technologies of scientific communication in the state and foreign languages ​​(UC-4);

- the ability to follow ethical standards in professional activities (UC-5);

- the ability to plan and solve problems of their own professional and personal development (UC-6);

- the ability and willingness to prove theoretically and optimize the technological processes of obtaining advanced materials and the production of new products from them, taking into account the consequences for society, the economy and the environment

(GPC-1);

- the ability and willingness to develop and produce technological documentation for advanced materials, new products and measures of technical quality control of manufactured products (GPC-2);

- the ability and willingness to economically evaluate the production and non-production costs of creating new materials and products, to work to reduce their cost and improve quality (GPC-3);

- the ability and willingness to use in practice the integrated knowledge of natural science, general vocational-oriented and special disciplines for understanding the problems of materials science development, the ability to put forward and put into practice new high-performance technologies (GPC-5);

- the ability and willingness to develop technical specifications and programs of calculations and theoretical work and experimental work (GPC-9);

- the ability and willingness to participate in carrying out technological experiments, to carry out technological control in the production of materials and products (GPC-12).

As a result of mastering the discipline, a graduate student should:

**Know:**

**-** themain scientific schools, directions, concepts, methodology of scientific research;

- the main trends in the development of metallurgy and materials science and requirements for raw materials, metals, analytical methods, multi-criteria optimization problems of metallurgical processes, materials, their properties and methods of production.

**Be able to:**

**-** create and analyze mathematical models of the studied processes and objects.

**Aquire** (demonstrate skills and experience):

- solving optimization problems.

**2. CONTENT OF THE DISCIPLINE**

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| --- | --- | --- |
| **Code of**  **sections, topics** | **Section, topic of the discipline** | **Content** |
| **Р1** | **Principles of creating new materials** | General requirements for materials and methodological principles of decision making when creating new materials and technologies for machine parts, structures and tools.  The principles of creating new structural steels and technologies for their hardening processing in mechanical engineering.  Principles of creating new tool steels and alloys and technologies of their hardening heat treatment |
| **Р2** | **Special steels and alloys** | Special steels and alloys: corrosion-resistant, heat-resistant, heat-resistant, heat-resistant, wear-resistant |
| **Р3** | **Materials processing technologies** | Formation of the structure, properties and principles of choice of cast irons and their processing technologies in mechanical engineering.  General principles and procedures for selecting and creating materials and technologies for hardening heat treatment of machine parts.  Using computer programs to solve problems in the choice of material and technology |

**4.3.3 Indicative topics of individual or group projects**

**Section 1**

General requirements for machine parts, structures and tools. Criteria of strength, reliability and durability

Carbon steel. Constructional steels for various purposes

Classification, marking and selection of tool steels

Technology of preliminary heat treatment of tool steel blanks

**Section 2**

Wear resistant steel

Steel resistant to temperature and working environment

Cast iron classification

The basic principles of the choice of cast iron for machine parts

**Section 3.**

Selection of metal alloys and hardening technology of machine parts and tools

Tasks for the selection of materials

Examples of solving problems in the choice of materials and technologies of hardening processing for specific machine parts.

**6.3.4. List of indicative questions for the credit**

1. What are the processes of heat treatment, which give the minimum deformation of the workpiece?

2. What is the difference between endogas atmospheres? Can they be considered as alternative?

3. What should be understood by the terms route and operational technologies?

4. What is the difference between the technology of thermal and chemical-heat treatment of products? Can these processes be considered as alternative?

5. Tell us about the features of heat treatment technology using salt baths as heating equipment. Indicate the disadvantages of such technologies.

6. What parameters of industrial heat treatment technologies can be considered as decisive when choosing alternative options?

7. What are the variants of technological processes that give minimal deformations of products during heating and cooling (quenching)?

8. What are the operations of heat treatment of steel, which can be called energy-saving?

9. What are the technological processes that can be analogous to the cementation technology?

10. What are the main industrial methods of heating simple carbonaceous steels. Give them a brief economic description.

11. Formulate the basic parameters of practical technologies suitable for industrial applications.

12. Briefly describe the nature of the deformation phenomena during heat treatment of parts.

13. Name the tool materials used in modern engineering.

14. Formulate the main causes of volumetric deformations during heat treatment of parts.

15. List the main ways to protect steel products from oxidation during heating, which can be considered as alternatives.

16. How will the properties of hardened carbon steels and high-alloyed high-speed steels differ?

17. For which steel “cold working” can be of practical importance? Why?

18. For which tool materials does heat treatment not make sense and therefore not carried out?

19. What does practice against deformation during heat treatment of long products?

20. What principles underlie the choice of the type of protective atmosphere?

21. What is the fundamental difference between the cooling processes during the hardening of steel products in water and in oil?

22. What are the types of stresses that occur during cooling of steel and cast iron products.

23. What will be different technological options for heat treatment of steel 20X and 40X?

24. What are the main components of the endogas protective atmosphere.

25. List and give a brief description of the main parameters of the choice of technological options for heat treatment of engineering parts.

26. Outline the basic principles for calculating and choosing the heat output of heating devices for practical heat treatment processes. What data should be taken as the initial parameters of the design of thermal production technologies.

27. Nitriding and carbonitriding are surface types of hardening of parts than, in principle, will the parts that have undergone cementation treatment and nitration be different?

28. What are the finishing operations applied practice tool production to further improve the quality of the 1st order tool?

29. Features of the choice of options for the process of heat treatment of material for elastic elements used in mechanical engineering.

30. Thermal analysis of alternative surface heat treatment of gear teeth after gas carburizing, gas cyanidation and high-frequency hardening.

31. The choice of material for machine parts, hardened by nitriding. Properties of the nitrated layer; recommendations on the working conditions of nitrided parts.

32. Prediction of the mechanical properties of materials after various types of heat treatment. Possibilities of computer simulation of changes in the mechanical characteristics of materials.

**7. TRAINING-METHODOLOGICAL AND INFORMATION SUPPORT OF THE DISCIPLINE**

**7.4. Databases, information and reference and search engines**

* <http://www.thermophysics.ru/>
* <http://www.skladmetalla.ru/>
* [lib.urfu.ru](http://lib.urfu.ru/)   
  Electronic catalog of the Regional Scientific Library of UrFU