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

**DEVELOPMENT PROSPECTS OF ENERGY AND RESOURCE SAVING TECHNOLOGIES OF FERROUS METALLURGY**

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| **The list of information about the work program of the discipline** | **Credentials** |
| **Educational program**  Prospects for the development of energy and resource saving technologies ferrous metallurgy(05.16.02) | **Code of EP** 22.06.01  **Curriculum** № 6513 (version 2) |
| **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**

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

The discipline aims to study the characteristics of the physicochemical processes that underlie the technological processes for producing ferrous metals, and modern methods for analyzing the basic processes for the production of iron-based alloys, methods for mathematical modeling of technical systems, experimental techniques and environmental aspects of pyrometallurgical technologies.

**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 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 and willingness to prove theoretically and optimize the technological processes of obtaining promising 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 means 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 comply with regulatory requirements that ensure the safety of production and operational activities (GPC-4);

- 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 perform theoretical and experimental research as a leading performer using computer technology (GPC-6);

- the ability to choose instruments, sensors and equipment for conducting experiments and recording their results (GPC-10);

- the ability and willingness to develop a process, tooling, working documentation, route and operational flow charts for the manufacture of new products from advanced materials (GPC-11);

- 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);

- the ability and willingness to participate in the certification of materials, semi-finished products, products and technological processes of their manufacture (GPC-13);

- the ability and willingness to assess investment risks in the implementation of innovative materials science and design and technology projects and the introduction of advanced materials and technologies (GPC-14);

- the ability and willingness to demonstrate a systematic understanding of the current state and perspective of selected (professional) industry of scientific knowledge (PC- 1);

- the ability and willingness to conduct research in the chosen (professional) branch of scientific knowledge using modern methods and technologies (PC-2);

- readiness to identify, develop problems, using the scientific approach, conduct and implement the results of research in the selected (professional) branch of scientific knowledge (PC-3).

- the ability to critically analyze, evaluate and synthesize new ideas in the chosen (professional) branch of scientific knowledge, related fields (PC-6);

As a result of mastering the discipline, the student must:

**Know:**

- the main achievements in the field of theory and technology of pyrometallurgical processes;

- modern methods of theoretical analysis of pyrometallurgical processes;

- methods of formulation and solution of improvement of the technology of pyrometallurgical processes.

**Be able to:**

**-** formulate the tasks of theoretical and technological research;

- apply the achievements of science in the technological practice of pyrometallurgical processes.

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

- methods of thermodynamic analysis of pyrometallurgical processes:

- algorithms of numerical methods for calculating and optimizing technological processes.

**2. CONTENT OF THE DISCIPLINE**

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| **Code of**  **sections, topics** | **Section, topic of the discipline** | **Content** |
| **Р1** | **Introduction** | The purpose of studying the discipline. The urgency of the problem of modern technologies for the production of iron-based alloys. Perspective directions of development of ferrous metallurgy in the world and Russia. |
| **Р2** | **Current issues of the theory and technology of ore-heating processes** | Theoretical foundations of studying the relationship between the processes of heat exchange, reduction and oxidation of iron oxides, mineral formation and crystallization. Modern technological solutions to ensure the production of high quality raw materials for blast furnace smelting. Methods of analysis of thermodynamics and kinetics of recovery processes of blast-smelting. The theoretical basis for the production of iron with a low content of silicon and titanium. Modern approaches to modeling the physicochemical processes of the blast shop. Modern methods of analyzing the operation of blast furnaces. |
| **Р3** | **Current issues of the theory and technology of steel production** | Fundamentals of fluid theory from the standpoint of statistical mechanics. Statistical models of multicomponent systems. The problem of non-equilibrium liquid metal and technological reserves for improving the quality of steel. The problem of energy saving in the modern arc steelmaking process. The current state of after-treatment has become open processes. Ways of progress. The current state and ways of progress of continuous casting of steel. |

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

**1.** Physical and chemical bases of technological processes of agglomeration of iron ore raw materials.

2. Disadvantages of existing and promising technologies for the agglomeration of iron ore.

3. Modern and advanced equipment for the preparation of ores for blast furnace smelting.

4. Methods for assessing the energy efficiency of technological schemes for the preparation of ores for smelting.

5. Physical and chemical bases of coke-less metallurgy.

6. Physical and chemical approaches to assess the quality of iron ore raw materials ..

7. Physical and chemical bases of studying the reduction processes of blast-smelting.

8. Modern concepts and methods of mathematical description of heat transfer in a blast furnace.

9. Physical and chemical approaches to the choice of slag compositions for smelting iron.

10. The relationship between the development of the basic processes of blast-smelting.

11. Patterns of motion of gases and melts in a blast furnace.

12. Trends in the improvement of equipment and design of the blast furnace.

13. Physical and chemical bases of measures aimed at reducing energy consumption for smelting iron.

14. Methods of modeling blast smelting processes.

15. Control the progress of the domain process.

16. Physical and chemical bases of technological processes for production of steel semi-products.

17. Physical and chemical bases of the technology of out-of-furnace steel refining ..

18. Constructions of modern steel-smelting units and prospects for their development.

19. Ways to reduce energy costs in the production of steel ..

20. Mathematical models of physical and chemical processes of steel production.

21. The use of thermodynamics and kinetics methods in the description of steel production processes.

22. Theoretical basis for the production of continuously cast billets.

**7. TRAINING-METHODOLOGICAL AND INFORMATION SUPPORT**

**OF DISCYPLINE**

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

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| Site | Name |
| http://library.urfu.ru | Site of regional research library of UrFU |
| http://www.ingentaconnect.com | Search engine of foreign scientific and technical journals |
| http://ru.wikipedia.org | Free encyclopedia |
| http://www.elibrary.ru | Russian electronic scientific library |
| http://www.sciencedirect.com | Search engine of scientific publications |
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**7.6. Methodical recommendations for students on the development of the discipline**

The methodological features of the discipline include: the predominance of complex theoretical material, the need for logical and systemic thinking, the use of mathematical knowledge. In this case, it is planned to continuously monitor the mastering of the material in the discipline and to adjust the presentation of the content of the discipline. To improve the quality of performance of the planned types of independent work of students, it is planned to use modern technical means of training, technologies and methods of conducting classroom study work.

For the successful development of the discipline, students are recommended:

- to read the schedule of the educational process of the discipline (calendar schedule of classes and the schedule of independent work), the procedure for forming the final grade for the discipline, the principles of point-rating system for evaluating educational achievements;

- use the resources of the electronic library of UrFU and other universities, Internet resources;

- to develop and improve the ability to take notes, systematize, summarize the material studied, highlight complex issues that require additional training, make a preliminary plan for independent work. In case of difficulty in understanding individual issues, it is necessary to consult with a leading teacher;

- when preparing for practical classes, carefully study the theoretical material and not miss lectures;

- when preparing for lectures, it is recommended to review the material of previous lectures, which contributes to understanding and good mastering of the content of subsequent lectures;

- when studying calculation methods, it is advisable to consider examples of calculations given in lectures and literature.

In the case of skipping classes, do not delay the implementation of the planned control activities in the discipline, if necessary, work out educational material at the time specified by the teacher.