NJSC "ABYLKAS SAGINOV KARAGANDA TECHNICAL UNIVERSITY

Academic Council
Minutes No. 11
dated "07" 06 2024.

PROGRAM
OF THE ENTRANCE EXAMINATION
for enrollment in doctoral studies
Educational program 8D07203 "Metallurgy"

Department: "Nanotechnology and Metallurgy"
Compiled by:
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Candidate of Technical Sciences, Associate Professor Naboko E.P.

The entrance exam to doctoral studies consists of writing an essay, taking a test on readiness for doctoral studies, an exam on the profile of the educational program and an interview.

Persons who have a certificate (TOEFL ITP (Test of English as a Foreign Language Institutional Testing Program) take an additional English language proficiency test before the entrance exam for doctoral studies. The number of test tasks of the additional English language proficiency test is 100 questions. The maximum number of points is 100 points. The additional English language proficiency test is evaluated in the form of “admission” or “non-admission”. In order to get the grade of “admission” it is necessary to score at least 75 points.

Evaluation of the entrance exam for doctoral studies:

- interview - 20 points;
- essay - 10 points;
- passing the test on readiness for doctoral studies - 30 points;
- exam on the profile of the group of educational programs - 40 points.

The passing score for admission to doctoral studies under the state educational order is 75 points, the passing score for admission to doctoral studies on a paid basis is 75 points.

The duration of the entrance examination is 4 hours, during which the applicant writes an essay, takes a test on readiness for doctoral studies, answers an electronic examination ticket consisting of 3 questions.

The exam on the profile of the educational program includes 3 questions, of which: The 1st question determines the level and systematicity of theoretical knowledge; the 2nd question reveals the degree of formation of functional competencies; the 3rd question is aimed at determining the systemic competencies.

When preparing for the exam, it is recommended to use the literature given in the list, as well as modern periodical scientific and technical literature.

ESSAY TOPICS

The essay is a reasoned written statement of the author's position on the problem posed on the basis of independently conducted analysis using concepts and analytical tools of scientific knowledge.

The aim is to determine the level of analytical and creative abilities, expressed in the ability to build their own argumentation on the basis of theoretical knowledge, social and personal experience.

The essay should not contain graphic objects, symbols and formulas. The recommended number of words in the essay is 250-300.

Essay topics: metallurgy in general and branches of metallurgy from the position of present and future development; the role and place of metallurgy in the state economy; tasks of metallurgist-researcher, metallurgist-educator; modern views on ecology and resource saving in metallurgy.

Example essay topics:

The current state of the nanotechnology in the metallurgy and the prospects of the nanotechnology in the metallurgy.

The ferrous metallurgy and its prospects.

The metallurgy of the non-ferrous metals and its prospects.

The current state of the metallurgy and its prospects.

The current state of the powder metallurgy and its prospects.

The profession of the metallurgist is the profession of the future.

The role of the metallurgical-scientist.

The role of the metallurgist-researcher.

The role of the metallurgist-teacher.

Modern resource-saving technologies in metallurgy.

Questions for the examination on the profile of the educational program should provide an assessment of the professional level of the examinee for his/her admission to doctoral studies and, in general, determine the competencies necessary for training on the scientific and pedagogical profile.

TOPICS OF THE TERMS SUBMITTED FOR THE ENTRANCE EXAMINATION

1. "Modern technologies and equipment in metallurgy"

Metallurgical productions, development of equipment complex for modern compact metallurgical productions on the basis of combined foundry-rolling units for production of long products of wide assortment with high consumer properties. Technological processes in metallurgy; implementation of new methods in production, innovative development in metallurgy.

Literature:

1. Voskoboynikov V.G., Kudrin V.A., Yakushev A.M. General metallurgy: textbook for universities. - Moscow: ICC "Akademkniga", 2015. - 768 p.
2. Naboychenko S.S., Ageev N.G., Doroshkevich A.P. etc. Processes and apparatuses of non-ferrous metallurgy. - Ekaterinburg:GOU VPO UGTU-UPI, 2005. -700 p.
3. Sotnikov A.I., Grachev S.V., Lyashkov V.B., Naboychenko S.S., Furman E.L. Metallurgy. - Ekaterinburg: SEI HPE UPI-UFU, 2001. - 398 p.
4. Gazaliev A.M., Egorov V.V., Isin D.K. General Metallurgy: Textbook. - Almaty: Bilim, 2020. - 775 p.
5. Dosmukhamedov N.K., Dauletbakov T.S., Egizekov M.G., Merkulova V.P., Panfilov V.P. Copper production of Kazakhstan. - Almaty: Pub "DPS", 2020. - 472 p.
6. Digonsky S.V. Theoretical bases and technology of reductive smelting of metals from uncoated raw materials. - Moscow: Nauka, 2017. - 235 p.
7. Semenov B.I., Kushtarov K.M. Production of metal products in solid-liquid state. New industrial technologies. - Moscow: Bauman Moscow State Technical University, 2020. - 310 p.
8. Nikiforov V. M. Technology of metals and other structural materials. - Moscow: Polytechnic, 2016. - 185 p.
9. https://www.youtube.com/playlist?list=PLIem_ZrhCE0X_ISeSRsrEofWRLJyrOudi

10. Technologial processes of machinery production: tutorial for students, undergraduates, doctoral / M.K. Ibatov [et al.]. Ibatov [et al.]. - Karaganda: KSTU, 2019. - 260 p.
11. Higgins R.A. Engineering Metallurgy: Applied Physical Metallurgy. - London: J.W. Arrowsmith Ltd, 2013. - 552 p.
12. Makasheva A.M. Modern technologies and equipment in metallurgy: Textbook. - Karaganda: Karaganda State Technical University, 2021. - 98 p.
13. Narembekova A. K. Hydrometallurgical methods of copper-containing solutions processing: monograph for undergraduates. - Karaganda: Karaganda State Technical University, 2019. - 106 p.

2. “Theory of metallurgical processes”

Basic metallurgical processes. Physicochemical bases of metallurgical processes. Thermodynamics and regularities of interaction of gases and complex gas atmospheres. Chemical strength of structures, compounds, defectiveness of crystal structures. Mechanism and kinetics of oxidation of solid metals. Basic theoretical provisions on the mechanism of reduction of metals and solid oxides. Interaction of sulfides with gases, metals and oxides. Carburizing of iron by carbon oxide. Structure and properties of metallurgical melts. Thermodynamics of slag systems. Interaction of dissolved elements on the basis of iron. Thermodynamic regularities of the reaction of carbon oxidation in oxygen-containing iron. Kinetics of high-temperature heterogeneous metallurgical reactions. Kinetic regularities of decarburization reaction. Enlargement and phase separation rate.

Literature:

1. Adylkanova, M.A. Theory of metallurgical processes Theory of metallurgical processes: textbook Ministry of education and science of republic of Kazakhstan. - Almaty: Association of higher educational institutions of Kazakhstan, 2016.
2. Zhukebaeva, T. Zh. Physico-chemical fundamentals in foundry production: textbook - Karaganda: Karaganda State Technical University, 2014.
3. Zhukebaeva, T. Zh. Methodical instructions for laboratory classes in the discipline “Theory of metallurgical processes”: Ministry of Education and Science of the Republic of Kazakhstan, Karaganda State Technical University, Department of “Nanotechnology and Metallurgy”. - Karaganda: Karaganda State Technical University, 2014.
4. Tulegenova, Sh.N. Theory of mass and heat exchange in metallurgical processes: textbook for undergraduate and graduate students Ministry of Education and Science of RK, Karaganda State Technical University, Department of “Nanotechnology and Metallurgy”. - Karaganda: Karaganda State Technical University, 2017.
5. Enrichment and preparation of ores for smelting: textbook Ministry of Education and Science of the Republic of Kazakhstan, Karaganda State Technical University, Department of “Nanotechnology and Metallurgy”. - Karaganda: Karaganda State Technical University, 2018.

6. Metalurgija https://ores.su/ru/journals/metalurgija/
7 https://studio.youtube.com/channel/UCKq3SKC02iCb4BgI5B68Kdw/playlists

3. “Innovative technologies in metallurgy”

Advantages and disadvantages of modern technologies of production of metals and alloys; methods of quality control in the production process; technologies for obtaining advanced metals and alloys, nanotechnology.

Literature:

1. Ashkeev J.A. Planning and processing of experimental results: textbook for master's and doctoral students / Zh.A. Ashkeev, V.A. Talmasan; Ministry of Education and Science of the Republic of Kazakhstan, Karaganda State Technical University, Department of “Nanotechnology and Metallurgy”. - Karaganda: Karaganda State Technical University, 2017. - 89 p.
2. Prakhov, B.G. Invention and patenting: reference edition / B.G. Prakhov, N.M. Zenkin. - 2nd edition, revision and addendum - Kiev: Tehnika, 2011.- 256 p.
3. GOST 7.32-2001. Report on scientific research work. Structure and rules of execution.
4. Muravyev O.P. Planning and processing of experimental results: textbook for graduate students and university students / O.P. Muravyev, N.Zh. Karsakova; Ministry of Education and Science of the Republic of Kazakhstan, Karaganda State Technical University. - Karaganda: Karaganda State Technical University, 2013. - 129 p.
5. Fundamentals of scientific research: Textbook for technical universities / V.I. Krutov, I.M. Grushko, V.V. Popov et al. Popov etc.; ed. by V.I. Krutov, V.V. Popov. Popov. - Moscow: High School, 2011. - 400 p.
6. Patenting: Textbook for universities / E.I. Artemiev, M.M. Boguslavsky, R.P. Yesterday and others; ed. by V.A. Ryasentsev. - 3rd ed. revision and add. - M.: Mashinostroenie, 2011. - 352 p.
7. Kvon Sv.S. Improving properties of cast parts of agricultural machinery by the nanomodification method // Proceedings of the Conference “Engineering for rural development”, May 26-28, 2021, Jelgava, Latvia, 2021. - p.308-313.
8. Samgin, Y.S. Patent research and technical level of scientific developments: scientific edition / Y.S. Samgin, R.A. Tursunbaev, G.M. Dzhilkibaeva. - Alma-Ata: Science, 2011. - 178 p.

4. “Technology of metallurgical production”

Theoretical foundations of metallurgical processes. Physicochemical foundations of combustion. Theoretical bases of reduction processes. Theoretical bases of oxidizing melting. Input materials of metallurgical production. General characterization of blast furnace smelting processes. Formation of pig iron and slag. State Standards for pig iron. Steel production. Oxygen-converter process. Modern state and prospects of furnace processes of steel production. Steel production in

electric furnaces. Melting of steels and alloys in open and vacuum induction furnaces. Production of ferroalloys. Classification of non-ferrous metals. Pyro-, hydro- and electrometallurgical methods of non-ferrous metals production. Metallurgy of copper. Aluminum metallurgy. Production of refractory metals.

Literature:

1. Abdulina, S.A. Metallurgical production Technology Metallurgical production technology: textbook / S.A. Abdulina, G.A. Kokayeva, Zh.S. Onalbayeva; Ministry of education and science of republic of Kazakhstan. - Almaty: Association of higher educational institutions of Kazakhstan, 2016.

2. Voskoboynikov V.G., Kudrin V.A., Yakushev A.M. General metallurgy. Moscow: Akademkniga, 2016. 786 p.

3. Sarkenov, B.B. Preparation of ores for smelting: textbook for students and graduate students / B.B. Sarkenov. - Karaganda: Karaganda State Technical University, 2017. - 102 p.

4. Wegman E.F., Zherebin B.N., Pokhvisnev A.N. et al. Metallurgy of pig iron. Moscow: Akademkniga, 2014. 774 p.

5. Shishkin Y.I., Torgovets A.K., Grigorova O.A. Theory and technology of converter processes. Almaty: Gylym, 2016. 192 p.

6. Kablukovsky A.F. Production of electric steel and ferroalloys. Moscow: Akademkniga, 2013. 511 c.

7. Torgovets A.K., Shishkin Y.I., Artykbaev O.A. Theory, technology and equipment of out-of-furnace processing of metals. Almaty: Gylym, 2014. 273 p.

8. Utkin N.I. Production of non-ferrous metals. Moscow: Intermet Engineering, 2014.

9. Dorokhina L.N. Light non-ferrous metals and alloys. M.: All-Union Scientific Research Institute of Non-Ferrous Metals, 2019

10. Tikhonov B.S. Heavy non-ferrous metals and alloys. Moscow: All-Union Scientific Research Institute of Non-Ferrous Metals, 2019

11. Shishkin Y.I. Lukin G.P. Metallurgical calculations. Almaty: RIC UIML, 2012

5. “Planning and processing of experimental results”

Planning an experiment to solve experimental problems. Problem statement, selection of optimization parameter and factors. Full factorial experiment (FFE). Fractional factor experiment (FFE). Property of full and fractional factor experiment. Conducting the experiment. Checking the adequacy of the chosen model. Steep ascent of the response surface. Calculation of regression coefficients. Models and checking their statistical significance. Steep ascent of the response surface.

Literature:

1. Ashkeev J.A. Planning and processing of experimental results: textbook for master's and doctoral students / J.A. Ashkeev, V.A. Talmasan; Ministry of Education and Science of the Republic of Kazakhstan, Karaganda State Technical University,

Department of “Nanotechnology and Metallurgy”. - Karaganda: Karaganda State Technical University, 2017. - 89 p.

2. Prakhov, B.G. Invention and patenting: reference edition / B.G. Prakhov, N.M. Zenkin. - 2nd edition, revision and addendum - Kiev: Tehnika, 2011. - 256 p.

3. GOST 7.32-2001. Report on scientific research work. Structure and rules of execution.

4. Muravyev O.P. Planning and processing of experimental results: textbook for graduate students and university students / O.P. Muravyev, N.J. Karsakova; Ministry of Education and Science of the Republic of Kazakhstan, Karaganda State Technical University. - Karaganda: Karaganda State Technical University, 2013. - 129 p.

5. Fundamentals of scientific research: Textbook for technical universities / V.I. Krutov, I.M. Grushko, V.V. Popov et al. Popov et al.; ed. by V.I. Krutov, V.V. Popov. Popov. - Moscow: High. sch., 2011. - 400 p.

6. Patenting: Textbook for universities / E.I. Artemiev, M.M. Boguslavsky, R.P. Yesterday and others; ed. by V.A. Ryasentsev. - 3rd ed. revision and add. - M.: Mechanical engineering, 2011. - 352 p.

7. Kvon Sv.S. Improving properties of cast parts of agricultural machinery by the nanomodification method // Proceedings of the Conference “Engineering for rural development”, May 26-28, 2021, Jelgava, Latvia, 2021. - pp.308-313.

8. https://www.youtube.com/playlist?list=PLIem_ZrhCE0XWtxcRrmsC86IM8LTREtQS

Example of questions:

First block

1. Fluxes of non-ferrous and ferrous metallurgy.
2. Metallurgical fuels and other types of energy of metallurgical plant.
3. Causes of reduced recovery of metals in concentrates.
4. Complex processing of iron ores.
5. Characterization of the main products of metallurgical processing.
6. Principles of increasing the complexity of ore utilization.
7. Processing of subgons, dusts and gases.
8. Smelting behavior of rare, disseminated and noble metals.
9. Autogenous processes in metallurgy.
10. Classification of metallurgical slags.

Second block

1. Graphically depict the algorithm of model creation when modeling technological processes and objects. Give a brief characteristic of the main stages of model building.
2. Depict the scheme of interaction of ASTRA program blocks.4.
3. Decipher the grade of alloy: Decipher the grade of alloy VSt 5; 40XN2MA; Br.KMts 3-1; L 92; KCh 35 - 5; Br O5CNS5; 08X18G8N2T; U13.

4. Determine by empirical formula the cutting speed when trimming the end from diameter D=120mm to diameter d=50mm in a workpiece made of steel 30L with tensile strength. The workpiece is a casting with a crust. Lathe undercutting face cutter equipped with a plate made of T5K10 carbide. Cutting depth t=3mm, feed s=0,47mm/rev, period of resistance of the cutter T=45min. Geometric parameters of the cutter: shape of the front surface - radiused with chamfering

5. Draw the Fe-Fe_3C, diagram of state, indicate the structural components in all regions of the diagram, describe the transformations and construct a cooling curve in the temperature range from 1600 to 0 ^oC (using the phase rule) for an alloy of a certain concentration. For the same alloy determine by the rule of sections at a given temperature: the percentage of carbon in the phases, the quantitative ratio of phases.

6. Construct a double state diagram for components that have limited solubility and experience a eutectic transformation. Describe all transformations and phases in the diagram. For an alloy in any two-phase region, show the operation of the phase rule and the cutoff rule.

7. On the Fe-Fe3C diagram, show the alloy corresponding to the carbon content of 110G13 steel. Describe all phase and structural changes that occur in the alloy when heated to the liquidus line. Plot the heating curve using the phase rule.

8. Depending on the nature of the processes studied in the system, all types of modeling can be summarized in a scheme. Visualize it.

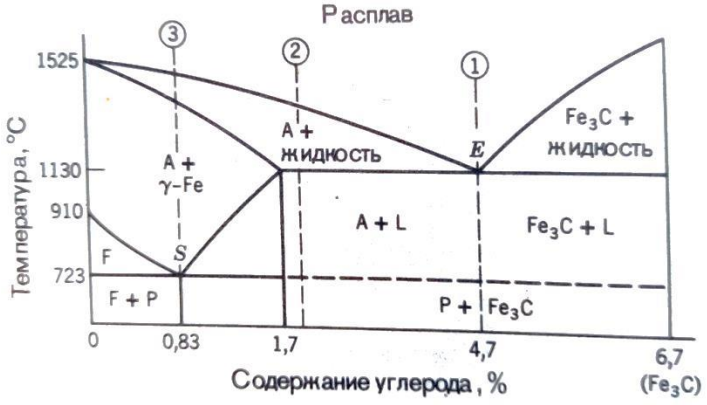
9. The mass of a rock sample in dry state in air is m_1 = 60 g. After paraffinization of its surface, its mass in water is m_2 = 37 g. The paraffin consumption m_p = 0,6 g, and its true density ρ_d = 0,9 g/cm^3. The density of water is ρ_w = 1000 кг/$м^3$. Calculate the average density of the rock.

10. Опишите теплопроводность стенок различной конфигурации при г.у. I рода.

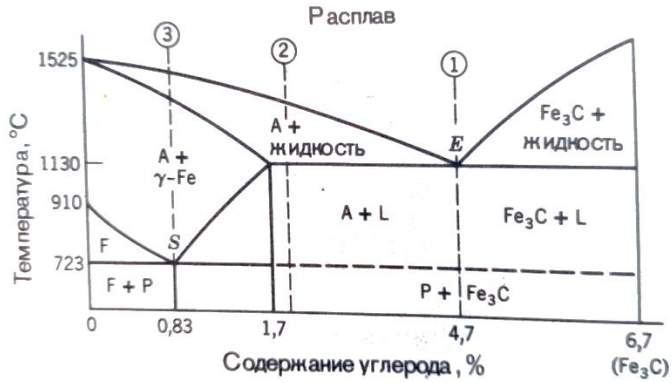
Third block

1. The blast furnace and other devices for smelting various metals must be lined on the inside with a substance that resists well the chemical action of the furnace contents. Why should a lining made of CaO or MgO not be used for smelting elements from acid ores, such as those rich in silica? What substances are more suitable for treating acid ores?

2 Discuss the effect of temperature on the Fe3C-3Fe+C reaction and compare your conclusions with the data (figure).



3. Using the phase diagram shown in the figure, explain why an Fe-C alloy containing 1% carbon can be hard and brittle or flexible and malleable depending on the rate at which it is cooled from an initial temperature of 1400 ºC.



4. Graphically depict the algorithm of model creation when modeling the technological process of steel melting.

5. Let there be some sequence of experimental values 10, 20, 15, 14, 13, 10, 19. The variation series in this case will have the form 10, 10, 13, 14, 15, 15, 19, 20.

6. For a given variation series, calculate the sample mean and standard deviation, assuming:

1) the obtained experimental results obey a normal distribution;

2) experimental results obey a “clogged” distribution.

7. 100 measurements of some physical quantity were made. Sample average x_{av} = 20, standard deviation S_x = 3, Student's criterion $t_{0,05;\ 99}$ = 1,96. Calculate the magnitude of the absolute error and present the interval of the mathematical expectation.

Describe the procedure for performing critical value screening in the initial processing of experimental results

8. Depict the process of CFE optimization by steepest ascent method.

9. Determine the minimum CO reducing agent flow rate (n, mol) required for the complete reduction of 1 mole of MnO oxides at a temperature of 1000 K.

10. Determine the minimum CO reducing agent flow rate (n, mol) required for the complete reduction of 1 mole of Cr_2O_3 oxides at 1000 K.

Head of NM Department **Aubakirov D.R.**

Approved at the meeting of the NM Department
Minutes No. 15 dated 03.04.2024.