MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education
"National University of Science and Technology M I S i S "

APPROVED
Vice-chairman
selection committee
_____ / A.A. Volkov
"___" _____ 2018

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Institute
Protocol № 1 from 2018
Director of Ecotech Institute
_____ / A.Ya. Travyanov
" 20 " sept. 2018

PROGRAM
ADMISSION TESTS
FOR APPLICANTS FOR THE TRAINING PROGRAMME MASTER DEGREE IN THE COURSE
22.04.02. METALLURGY

Moscow 2018

CONTENT

EXPLANATORY NOTE

The purpose of the admission test.

Assessment of the level of development coming competencies required for the master's program training

Form, duration of the admission test. Evaluation criteria.

The entrance examination is held in the direction of training in writing.

Lasting of admission test - 120 minutes.

Examination ticket contains 10 tasks. In the case of a correct answer receives the incoming number of points corresponding to the number of the question. The result of assessment work is the amount of points earned for correct answers to the relevant questions of written work.

The system of assessment of written entrance test:

1 question - 10 points;
2 question - 10 points;
3 question - 10 points;
4 question - 10 points;
5 question - 5 points;
6 question - 5 points;
7 question - 10 points;
8 question - 10 points;
9 question - 15 points;
10 question - 15 points.

Entrance test results are assessed on a 100 point scale.

Minimum passing score, confirming the successful completion of entrance examinations, is 40.

With equality of points in the rating number, priority is given to the candidate with a higher average grade diploma.

The list of accessories that applicant has the right to carry into the audience during the introductory test : pen, pencil, eraser, not programmable calculator.

ANNOTATION

The program proceeds to the magistracy in a direction "Metallurgy" is based on discipline, which is an important composing her undergraduate training program.

Discipline consists of separate sections:

1. Metallurgy ferrous metals.
2. Non-Ferrous Metallurgy.
3. The technology of mineral raw materials.
4. Thermal Physics of metallurgical processes.
5. Technology of foundry processes.
6. Functional materials and coatings.
7. Pressure Processing of Metals and Alloys.
8. Welding, soldering and brazing metals.
9. Metal Science base and precious metals.
10. Quality management in metallurgy.
11. Analytical quality control of steel products.

12. Advanced Metallic Materials and Engineering / Modern metal materials and engineering

13. "Multicomponent Nanostructured Coatings. Nanofilms"

Discipline is both theoretical and practical orientation in the field of modern technologies and equipment of metallurgical production, as well as the most progressive pieces of production methods and processing machinery parts pressure casting, welding, pressing, etc. It practically is the basis for a special technological training.

PART 1. ADVANCED METALLIC MATERIALS AND ENGINEERING

Section 1. Structures of Metals /1a, 2a, 3b/

Metallic Crystal Structures. Crystallographic Directions and Planes. Closed-Packed Crystal Structures. Single Crystals. Polycrystalline Materials. Determination of Crystal Structures by X-Ray Diffraction. Imperfection in Metals: Point Defects, Dislocations, Interfacial Defects, Bulk or Volume Defects. Microscopic Examination.

Section 2. Phase Transformations In Metals /1a, 2a/

Diffusion Mechanisms. Crystallization. Melting. The kinetics of Phase Transformation. Isothermal Transformation Diagrams. Solid Solutions. The Gibbs Phase Rule. Phases. Phase Equilibria.

Section 3. Binary Phase Diagrams /1a, 2a/

Interpretation of Phase Diagrams. Binary Isomorphous Systems. Solubility Limit. Lever Rule. Development of Microstructure in Isomorphous Alloys. Binary Eutectic Systems. Development of Microstructure in Eutectic Alloys. Equilibrium Diagrams Having Intermediate Phases or Compounds. Eutectoid and Peritectic Reactions. Congruent Phase Transformations. Mechanical Properties of Isomorphous Alloys.

Section 4. The Iron-Carbon System /1a, 2a/

The Iron-Iron Carbide (Fe-Fe3C) Phase Diagram. Development of Microstructure in Iron-Carbon Alloys (Carbon Steels and White Irons). The Iron-Graphite Phase Diagram. Development of Microstructure in Iron-Graphite Alloys (Gray Irons).

Section 5. Mechanical Properties /1a, 2a, 2b/

Stress–Strain Behavior. Anelasticity. Elastic Properties of Materials. Plastic Deformation of Polycrystalline Metals. Dislocations slip. Dislocations climb. Tensile Properties. True Stress and Strain. Strengthening mechanisms. Solid solution hardening. Precipitate and dispersion strengthening. Work-hardening. Hardness. Toughness. Impact toughness. Creep and creep fracture. Creep mechanisms. Fatigue failure. Fractographic Studies.

Section 6. Heat treatments /1a, 2a, 1b/

Homogenization annealing. Recovery. Recrystallization. Grain Growth. Stress-relief annealing. Full annealing of steel. Normalizing. Quenching of steel. Tempering of steel. Solution heat treatment. Aging.

Section 7. Metals and Alloys / Раздел 7. Металлы и сплавы /1a, 2a/

The generic metals and alloys: Iron-based, Copper-based, Nickel-based, Aluminium-based, Titanium-based alloys.

Recommended reading (main and additional) to Part

a) main reading

1a) William D. Callister, David G. Rethwisch. Fundamentals of Materials Science and Engineering: An Integrated Approach, 4th Edition. Wiley. 2012.

2a) Hōno Kazuhiro, Laughlin David E. Physical Metallurgy, 5th ed. Burlington : Elsevier. 2014

b) additional reading

1b) ASM Handbook, Volume 4, Heat Treating. ASM International. 2002

2b) ASM Handbook, Volume 8, Mechanical Testing and Evaluation. ASM International

3b) ASM Handbook, Volume 9, Metallography and Microstructures. ASM International. 2004

PART 2. MULTICOMPONENT NANOSTRUCTURED COATINS. NANOFILMS

Section 1. General questions

1.1. General classification of physical and chemical methods for coatings deposition. Methods for determining the thickness of coatings. Methods for determining the chemical and phase composition of coatings [1-4].

1.2. Main properties of the coatings deposited by chemical and physical vapor deposition (CVD and PVD), thermal spray technologies, and electrochemical deposition. Examples of the metallurgical coatings for the mechanical engineering, microelectronic, optic and medicine [1-7].

1.3. Technologies of deposition by welding in the recent metallurgy. Electro-arc, plasma, selective laser deposition, gas-flame welding deposition. Examples of deposition by welding application on metallurgical plants [1-3].

Section 2. Simple level

2.1. Materials for applications in the technologies of thermal spray (powders, wires, rods), ion-plasma deposition (cathodes-targets) and deposition by welding [1-5, 8].

Section 3. Average level

3.1 Methods of the deposition at atmospheric conditions. Flame spraying. Detonation spraying. Plasma spraying [1-3].

3.2. Biocompatible materials and coatings. Application of the coatings in the medicine [5-7].

Section 4. Hard level

4.1. Vacuum methods of coating deposition. Physical and chemical vapor deposition technologies. The interaction of ions with the surface of a solid. Magnetron sputtering. Cathodic arc evaporation [1-4].

4.2. Thermal spray deposition of the hard coatings. Features of the plasma, detonation, flame, electro-arc, and cold spray technologies. Advantages and disadvantages [1-3].

4.3. Main compositions of the hard wear-resistant coatings for improvement of the exploitation characteristics of the cutting tools. Requirements for this type of coatings. Structure features and properties [2-6].

4.4. Methods of coating deposition at atmospheric pressure. Row materials for coatings. Thermal spraying. Plasma spraying. Arc spraying. Detonation spraying. Flame spraying. Plasma and laser welding. Electrospark alloying [1-3, 6].

Recommended literature

1. Handbook of Deposition Technologies for Films and Coatings: Science, Technology and Applications, 2nd Edition: Edited by Rointan F. Bunshah, Noyes, Park Ridge, NJ, 1994, XXVI, 861 pp., ISBN 0–81 55–13372

2. M.G. Hocking, V. Vasantasree, P.S. Sidky. Metallic & Ceramic Coatings: : production, high temperature properties and applications. Longman Scientific & Technical, 1989, 670 p.

3. Engineering Coatings (Second Edition) Design and Application. Stan Grainger, Jane Blunt. Woodhead Publishing. 1998. p. 323. ISBN: 978-1-85573-369-5

4. Donald M. Mattox. Handbook of Physical Vapor Deposition (PVD) Processing (Second Edition), 2010, Elsevier/William Andrew. 746 p. ISBN: 978-0-8155-2037-5

5. Cavaleiro, Albano; Hosson, Jeff T. de (Eds.). Nanostructured Coatings. Series: Nanostructure Science and Technology 1st Edition., 2006, XX, 648 p. 353, ISBN: 978-1-4419-2064-5

6. Voevodin A., Shtansky D., Levashov E., Moore J. Nanostructured Thin Films and Nano dispersion Strengthened Coatings. Kluwer Academic Publishers, NATO Science Series, Series II: Mathematics, Physics and Chemistry - Vol. 155, 321 p.

7. Shtansky D.V., Levashov E.A., Sukhorukova I.V. Multifunctional bioactive nanostructured films, in book Hydroxyapatite (HAP) for biomedical applications. Ed.: M.R. Mucalo, Woodhead Publishing Series in Biomaterials: Number 95, Elsevier, 2015, 404 p

8. Levashov E.A., Pogozhev Yu.S., Kurbatkina V.V., Lin G., Kimura T., Susana M.M., Rivera T. Advances in Ceramics - Synthesis and Characterization, Processing and Specific Application. Edited by Costas Sikalidis, Published by INTECH, 2011, 520 p.