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ENTRANCE EXAMINATION CONTENT
FOR THE MASTER`S DEGREE PROGRAM IN
22.04.02 Advanced metallic materials and engineering

MOSCOW 2024

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1. 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.

2. EXAMINATION CONTENT OUTLINE

Section 1. Structures of Metals

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

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

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

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

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

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

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

Recommended readings (main and additional)

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