Approved at the Academic Council meeting
of the Ecotech Institute
№ 4 from 04.12.2025

ENTRANCE EXAMINATION CONTENT

FOR THE MASTER'S DEGREE PROGRAM

CODE 22.04.01 Materials Science and Technology / Материаловедение и технологии

Moscow 2025

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1. EXPLANATORY NOTE

The purpose of the entrance examination.

Assessment of thecandidat's level of preparation, background knowledge and competencies required for the master's program training "Materials Science and Technology".

Form, duration of the entrance examination.

Entrance examinations are held in the form of an interview with use of remote technologies.

The duration of the entrance examination is not to exceed 40 minutes.

Entrance examination results are assessed on a 100-point scale.

The maximum amount of points for the interview component is 100 points. Two questions derived from program content comprise the interview component. Each question is scored from 0 to 40 points. Additionally, the level of knowledge of professional terminology in English is being evaluated from 0 to 20 points. The results of the evaluation interview are the sum of points earned for each question and for the level of knowledge of professional terminology demonstrated in English.

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

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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

a) main reading

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

2a) Hon̄o 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