

Entrance tests

- Production of metallurgical coke. Its functions in a blast furnace
- Blast furnace recovery in a blast furnace and evaluation criteria.
- The essence of the production of iron ore pellets.
- Heat exchange in a blast furnace.
- Flow of furnace charge and gases in a blast furnace.
- Distribution of materials along the radius and circumference of the top.
- Change in the temperature of the charge and gases along the height and radius of the blast furnace.
- Formation of cast iron and slag in a blast furnace.
- Blower air heaters with a burner in the dome.
- Blast furnace charging devices.
- Sulphur removal during agglomeration
- Device for the discharge of pig iron and slag from blast furnaces.
- Desulphurisation of cast iron in the furnace hearth and during the release.
- Thermodynamics and kinetics of reduction of iron oxides in a blast furnace.
- Chemical composition, structure and properties of liquid slag of the steelmaking production.
- The design of an oxygen converter. Lining of converter.
- Steel processing in the ladle furnace.
- Oxidation of iron during steel smelting.
- Design of a modern arc steel furnace.
- Vacuum treatment of steel in the ladle.
- Carbon oxidation in steelmaking. The role of carbon oxidation reactions.
- Nitrogen in steel. Methods of reducing the nitrogen content in steel.
- The essence of the method for continuous casting of steel, its advantages over pouring steel into casting moulds.
- Oxidation and reduction of phosphorus in steelmaking. Removal of sulphur in steelmaking.

- Converter processes with combined purging.
- The crystalline structure of sections. The modern steel crystallisation theory.
- Heat exchange regularities in the sintering charge layer.
- Application of the Schumann's solution to the calculation of temperatures in the layer.
- Heat and mass exchange when firing iron ore pellets.
- The basic differential equation of heat and mass transfer during the drying of pellets.
- Differential equation of mass exchange processes during pellet firing.
- Restorative firing of pellets for metallisation purposes.
- The energy-efficient and resource-saving modes of agglomeration sintering and pellet firing.
- The properties of real ore melts during their reduction on a coke nozzle in a blast furnace.
- The physical nature of the structure of the dry and irrigated layer in the blast furnace
- The resistance features of the irrigated layer, the irrigation limits, the flooding phenomenon and the Sherwood-Zhavoronkov criteria.
- Heat exchange regularities of in modern blast furnace smelting.
- Three ways to calculate the overall heat balance of blast furnace smelting.
- Reflection of the two-stage theory in the method of compilation of thermal balances, analysis of individual items of the total heat balance of blast furnace smelting.
- Expression of each item of the heat balance through continuous information about the progress of the blast furnace.
- New views on the assessment of the thermal state of a blast furnace based on the features of heat-exchange, hydrodynamic and reduction processes in a blast furnace. The thermotechnical automation basis of the blast furnace process.
- Basic principles of controlling the thermal state of a blast furnace.
- The fuel injection regularities and analysis of the effects on the thermal state of a blast furnace.
- The fuel injection conditions. Calculation of the substitution equivalents by injection conditions. The limiting condition. The qualitative analysis of the effect of the top and bottom of the blast furnace on the thermal state.
- The heat and mass exchange in the melting bath. The melting mechanism taking into account mass-exchange processes (carburisation, melting of ferroalloys).
- The heat and mass exchange in the bubbling steelmaking bath. The design dependences of heat and mass transfer during bubbling.

- The heat and mass exchange in the continuous steel casting.
- The thermotechnical features of the converter production automation.
- The methods and analysis of the complex heat exchange. One-dimensional scheme, differential equation and its solutions.
- The zonal calculation method. Methods for determining the angular resolution of radiation coefficients.
- Improvement of zonal calculation methods. Accounting for the spectral characteristics of the media involved in the heat exchange. Determination of local characteristics of heat exchange.
- Accounting for the convective component. The analysis of longitudinal radiant fluxes.
- The mathematical zonal models of melting and heating furnaces.
- Determination of the main characteristics of the flare. The length of the flare, the radiation characteristics, the position of the flare relative to the heat-absorbing surface and line, the aerodynamic characteristics of the flare.
- Contemporary ideas about the effect of the main characteristics of the flare on heat exchange. The length of the flare, luminosity, taking into account the spectral characteristics of the flare, line and metal. The position of the flare relative to the heat-absorbing surface and line.
- Features of the direct and indirect heat exchange in melting and heating furnaces.
- The mutual effect of the radiant and convective heat exchange components. Heat exchange optimisation in smelting and heating furnaces.
- The theoretical bases of physical modelling of heat and mass exchange in metallurgical furnaces.
- The methodology for modelling the gas flow and heat exchange in metallurgical furnaces.
- Planning of experimental research of the heat and mass exchange in metallurgical furnaces. The research output processing and analysis.
- The structure of the heat balance of melting and heating furnaces in metallurgy.
- The main indicators of the furnace thermal performance in metallurgy and their analysis.
- The existing mathematical models of heat and mass exchange in blast furnaces.
- The existing mathematical models of heat and mass exchange in steelmaking furnaces.
- The existing mathematical models of heat and mass exchange in heating furnaces.
- The optimisation of heating modes for different purposes, i.e. maximum performance, minimum smoke and fuel consumption.
- The features of the application of information-modelling systems for the management of processes in metallurgy (by limit).

- The current state of metallurgy of heavy non-ferrous metals (concretisation) in Russia and abroad.
- The theoretical fundamentals of the autogenous ways of melting concentrates.
- The principles of non-waste technology implementation schemes at the non-ferrous metallurgy plants of the Urals.
- The key areas of intensification of fire and electrolytic refining.
- The features of the nickel production from oxidised and sulphide nickel and copper-nickel ores in Russia and abroad.
- The features of impoverishment of slags of the autogenous processes and converter slags. Obtaining elemental sulphur from residual gases.
- Ways of processing lead slags of current production from slag dumps of the past years.
- The contemporary continuous leaded lead refining processes.
- The analysis of schemes of zinc extraction from sulphide concentrates without any preliminary calcination.
- Hydrometallurgical schemes for processing of the collective sulphide concentrates and industrial products.
- The theoretical fundamentals and technology of electrochemical dissolution of cinder, concentrates and recyclables.
- The principles of complex processing of zinc-containing rare metal dusts.
- The theoretical fundamentals, features and practice of the implementation of jarosite-, goethite- and hematite processes.
- The properties and application of magnesium alloys.
- Methods of obtaining magnesium alloys.
- The electrolytic preparation of ligatures.
- The synthetic carnallite production.
- Methods for obtaining magnesium.
- The electrolysis feedstock requirements.
- The magnesium electrolyser designs
- Aluminum minerals and ores.
- Modifications of Al_2O_3 .
- The methods for obtaining, properties and application of dawsonite, pseudoboehmite and active aluminum oxide.

- The essence of the Bayer's method.
- The Bayer's method. The behaviour of impurities.
- The sintering method. Reactions are basic.
- Acid methods, advantages and disadvantages.
- The structure of aluminate solutions.
- Method Bayer, sintering.
- The features of bauxite leaching of Middle Timman.
- Raw materials of the alumina production in Russia.
- The main process schemes for the alumina production.
- The structure of alkaline-aluminate solutions.
- The basics of the aluminum electrometallurgy.
- The mechanism of electrode processes during the electrolysis of the geochemistry.
- The design of aluminum electrolyzers.
- Process upsets and eliminating them.
- The low-temperature electrolysis. The state, prospects and development.
- The properties and application of titanium.
- The TiCl_4 production technology.
- Technology of obtaining the spongy titanium.
- A sodium thermic method for the production of titanium.
- A comparison of the magnesium-thermal and sodium-thermal methods for the production of titanium.
- The main deposits of titanium ores.
- Preparation of the charge for chlorination.
- Electrolytic methods for obtaining titanium.
- Technology for making products from titanium.
- The structure of metals and alloys. The elastic and plastic deformation mechanism.
- Analysis of the deformation of metal in rolls.
- Differential equilibrium equations and their application.

- Metal stamping processes,
- The key process stages, heating, rolling, cutting and metal finishing.
- The essence of the drawing process, the main process indicators. Types of drawing.
- Profiling sheet rolls.
- The effect of plastic deformation on the properties of metals and alloys in hot and cold processing.
- Lubrication when drawing.
- The effect of drawing on the properties of steel.
- The metal rolling process.
- Slip between rollers and strips. Anticipation and lag.
- The slip-line technique (characteristics).
- Advantages and drawbacks of the drawing process in comparison with other metal working processes.
- The rolled stock (steel profiles and grades) and prospects for its development.
- The production of large, medium and small varieties and wire rod.
- The resistance to deformation and temperature-velocity mode of deformation.
- Methods for supplying lubricant to the deformation zone. Drawing in the hydrodynamic and hydrostatic modes.
- The elements of calibration of rolls of the shape mills.
- Metal forging.
- Process schemes for rolling.
- The structure of metals and alloys. Phases in alloys.
- Point, linear and surface defects of the crystalline structure of metals. Interaction of dislocations.
- Return, polygonisation and recrystallisation.
- Crystallisation of alloys. Mechanism and kinetics.
- The structure of the metal ingot. Modification of the cast alloy structure.
- Borders of grains and sub-grains.
- The eutectic solidification. The structure of eutectic colonies
- Diffusion laws. Diffusion mechanisms.

- Mechanism of hardening of steels during the plastic deformation.
- Texture in metals.
- Methods for studying the mechanical and physical properties.
- The mechanical properties at static loads
- The mechanical properties under dynamic loads
- The fragile and viscous fracture.
- The effect of carbon and impurities on the properties of steel.
- The structure and properties of gray cast irons.
- Aging of metals and alloys.
- Mechanism and kinetics of the pearlite transformation in steel.
- Phase transformations when steel is heated. The structural heredity.
- The modern metal structure research and control methods.
- Solid solutions of substitution, introduction. Superstructures.
- The effect of non-metallic inclusions on the mechanical properties of alloys
- Shift and normal transformation. Mechanism and kinetics.
- Methods for filling moulds.
- The homogeneous and heterogeneous crystallisation.
- Patterns of metal outflow from the bottom-pour and lip-pour ladles.
- Heredity of metals, its influence on the properties of castings, methods for eliminating heredity.
- Change in the properties of metals during heating, melting and overheating.
- Pouring gate systems, purpose and types.
- Modification of melts, types of modifiers,
- The influence of the nature of metals on the nature of oxidation.
- Capture of slag in gating systems.
- Liquefaction in alloys.
- Interaction of metals with hydrogen, nitrogen and complex gases.
- The volume shrinkage hole and shrinkage porosity,

- Reasons for the formation of gas porosity in castings.
- Liquid flow of melts, types of fluidity and factors affecting it.
- Linear and casting alloy shrinking.
- Non-metallic inclusions, their nature, influence on the structure and properties of castings.
- Fillability of moulds, influence of the mould material and melt properties on fillability.
- Factors affecting the stress state of castings.
- The mechanism of gas dissolution in metal.
- Defects caused by poor fluidity.
- Measures to prevent cracks in the castings.
- A schematic diagram of phase transformations of eutectoid structures when heated at various rates, for example, steel with 0.8% carbon content.
- A schematic diagram of phase transformations of the pre-eutectoid structures when heated at various rates, for example, steel with 0.45% carbon content
- A schematic diagram of the phase transformations of the hypereutectoid structures when heated at various rates, for example, steel with 1.3% carbon content.
- Diffusion transformations, for example, the decay of supercooled austenite of the eutectoid steel.
- Isothermal diagrams of decay of supercooled austenite by the diffusion mechanism in steels. Pearlite, sorbitol and troostite of cooling.
- Martensitic transformation in iron-carbon alloys. Morphology, kinetics. Residual austenite.
- The carbon behaviour during martensitic transformation in steels.

Supersaturated solid solutions by carbon.

- Influence of alloying elements on the course of martensitic transformation in steels.
- The effect of deformation of austenite on the martensitic transformation of metals.
- The effect of cooling rate on the mechanical properties of steels.
- The main regularities of the decomposition of supersaturated solid solutions while aging.