Entrance tests

Electromechanics and electrical apparatus

1. Physical processes in the transformer. Transformer equivalent circuit. The reduced transformer equations. Vector diagrams. Use of the transformer equivalent circuit in the calculation of the transformer modes and characteristics.

2. Features of the operation of three-phase transformers in connection with winding connection schemes and core design (connection groups, value 10 in phases, currents and third harmonic currents, currents and zero-sequence currents).

5. The principle of creating a rotating magnetic field in AC machines. Basic and higher spatial harmonics of the magnetomotive force and flow. Direction and frequency of rotation of the magnetomotive force harmonics.

6. Three-phase windings of stators of alternating current machines, both single-layer and two-layer. Analysis of windings using a star of the slotted EMF.

7. Windings of the rotors of induction motors, their design modifications improving the starting properties of engines.

8. The induction engine equivalent circuit. The physical essence of the equivalent circuit parameters. Slipping as a load factor.

9. Dependences of M = f(s), I_i = f(s). The characteristic points and multiplicity of moments and currents. Change in the type of the graph M = f(s) with the change in the parameters and design of the induction engine windings (the effect of the increased scattering, tooth saturation, changes in the active resistances of the windings, displacement of current in the rotor).

10. Types of excitation systems for synchronous machines. The anchor chain (resistance) parameters. The equations of the synchronous machine in the axes d, q rigidly connected with the rotor.

11. A synchronous generator operated in parallel with the network. Generation of the active and reactive power. Angular characteristics. U-shaped characteristics.

12. A synchronous compensator. The principle of operation, design features. Performance.

13. A synchronous motor. Description of the processes and characteristics. The design and application features. Start-up.

14. Design features and properties of the loop and wave windings of DC motor anchors (steps by the anchor and collector, the number of pairs of parallel branches, the presence of equalising connections). The concept of complex windings.

15. The magnetic field pattern in DC machines at idle and under load. The armature reaction with the position of the brushes on the geometric neutral and under shifts. The device and purpose of the compensation winding. Switching in DC machines.

16. The effect of the armature response to the characteristics of generators and DC motors. The features of the use of shunt and series windings in DC machines.

17. Power loss and efficiency in electrical machines. Types of losses in DC machines in comparison with other electrical machines and transformers. The concept of additional losses in electrical machines and transformers.

24. The review of the thermal calculation methods for electric machines. The essence of the method of thermal equivalent circuits. The types of thermal resistances and their physical nature. The determination of thermal resistances for various heat transfer conditions.

25. Calculation of the joint operation of the fan and ventilation duct. The graphic solution for ventilation circuits.

26. Methods and types of the cooling systems for electrical machines. The electrical machine ventilation calculation objectives.

27. The reason for the occurrence of hydraulic resistances. The types of hydraulic resistances, their physical nature. Equivalent hydraulic circuits.

28. The thermal modes of electrical apparatuses, methods for estimating the temperature field of electrical apparatuses.

29. The properties and characteristics of power elements of electrical apparatus based on direct current electromagnets; methods for evaluating their numerical values.

30. The properties and characteristics of power elements of electrical apparatus based on AC electromagnets; methods for determining their numerical values.

31. The operational and technical characteristics of contact connections; Methods of calculation: ways to improve the operational reliability of contacts.

32. Electrodynamic forces as a factor of the electrodynamic stability of electrical apparatus. Their main characteristics; Methods for determining the magnitude and direction. Properties and characteristics of induction-dynamic mechanisms.

33. The value of the electric arc in the electrical apparatus; the static and dynamic characteristics of the electric arc; basic equations that characterise the combustion regime of an electric arc.

24. Electric arc switching off of electric circuits of a direct current; the arc stability conditions according to Lyapunov.

25. Electric arc switching off of electric circuits of an alternating current; recovery voltage and recovery strength.

26. Diagrams, operation principle, characteristics and selection of the main equipment of electronic devices based on single-operation thyristors or based on transistors and bipolar thyristors.

27. Basic principles of construction of arcing systems of low voltage devices; their properties and characteristics.

28. Materials used in the design of apparatus; Their properties and characteristics.

29. Switching overvoltages when the circuit breaker switches off the capacitive load; key phenomena, the role of the switch, protection measures.

30. The electrical apparatus for protection of equipment against lightning and switching overvoltage; types, properties and characteristics.

31. Main types of low-voltage circuit breakers; Their design schemes; parameters and characteristics. Quick-operating circuit breakers; Methods for ensuring quick operation and current limitation.

32. Designation, principle of operation and basic characteristics of measuring electrical devices; methods for calculating their parameters.

33. The basic laws of the gas flow motion; Methods for calculating the gas-dynamic characteristics of electrical apparatus.

34. Relay elements and relay characteristics. Measuring and logic relays. The characteristic value and its setting; Main types of electromechanical relays and some circuits with their use.

35. Reed switches, the main varieties, typical characteristics and calculation methods.

36. The main varieties and structural components of the switching devices of the operating mode. Their singularities on constant and alternating currents. The current trends of switching control devices.

37. The main processes characterizing the interaction of the electrical system and high voltage switches. Calculation of recovery voltages; the principles of the selection of switches according to the conditions of switching-off of short-circuits.

38. Basic methods and schemes for testing apparatus in terms of the switching capacity; test modes ensuring the reliability of the apparatus operating conditions.

Subject area: Electrotechnical units and systems

1. Models of the electric drive mechanical part.

2. The mechanical part of the electric drive as an object of control. The structural scheme,

transfer functions and frequency characteristics.

3. The features of two-mass and multi-mass electromechanical systems.

4. The natural and artificial mechanical characteristics of a DC motor of independent excitation.

5. The natural and artificial mechanical characteristics of a DC motor with series excitation.

6. Methods for regulating the rate of a DC motor with independent excitation.

7. Methods for regulating the speed of a DC motor with series excitation.

8. The natural and artificial mechanical characteristics of induction motors.

9. The mathematical description and structural diagrams of open electromechanical systems (for example, a DC motor with independent excitation and a two-mass mechanical part).

10. Methods for regulating the speed of induction motors and their evaluation.

11. Methods for studying thermal processes in asynchronous electric motors.

12. The nominal thermal modes of operation of electric motors.

13. Methods for reducing losses in the electric drive.

14. Energy-saving technologies based on an AC drive.

15. The elements of electric drive control systems. Operational amplifiers, design features, varieties, the use for constructing regulators

16. The elements of digital control systems. Microcontrollers.

17. The principles of construction of subordinate regulation systems with sequential correction. Transfer functions of control loops and regulators.

The transient and frequency characteristics of circuits.

18. The principles of limiting coordinates in subordinate regulation systems.

19. The principles of construction of the position electric drive control systems. The synthesis of the position loop controller for small movements. The static and dynamic characteristics.

20. The systems designed to control position electric drives with a non-linear position controller. The features of the calculation of the characteristics of a nonlinear position controller.

21. The features of scalar control of asynchronous electric drives.

22. The structure of the automatic speed control system for the thyristor asynchronous electric drive with phase control. The static and dynamic characteristics

23. The features of the design of the vector systems of frequency-controlled electric drives.

24. The digital electric drive regulator synthesis methods.

25. The functional and structural circuits of digital rate controllers.

26. The converters for electric drives with DC motors.

27. The converters for electric drives with AC motors.

Subject area: Electrotechnology

1. Electrical heating. Development trends. Key advantages. Primary and secondary energy. Full process efficiency. The main types of electric heating. The scope of application.

2. Heat transfer methods. The quantitative characteristics of heat transfer. Temperature field.

3. Heat transfer by radiation. The heat transfer mechanism. The radiant heat transfer. Heat transfer by radiation between solids. The mutual radiation surface. Individual cases.

4. The heat conductivity equation in general form. Transition to a one-dimensional stationary problem. The thermal conductivity equations for a plane wall and a cylindrical wall under steady-state conditions.

5. The heat conductivity equation. Numerical methods for calculating temperatures in a two-dimensional area.

6. The convective heat transfer. Natural and forced convections. The heat transfer coefficient. The thermal resistance to heat transfer.

7. The thermal calculation of power engineering installations using equivalent thermal circuits.

8. The main types of electric resistance furnaces, both periodic and continuous. Structures, operating temperatures, applied heating elements, medium in the working space, voltage and power. The purpose of the muffle.

9. Electric furnaces with controlled atmospheres. The process groups associated with metal heating, in which it is advisable to use controlled atmospheres (the thermal treatment of products, the chemical and thermal treatment of products, special technological processes); The main controlled atmosphere, the field of application.

10. An energy diagram of induction of a power engineering installation.

11. The classification and scope of induction channel furnaces and induction crucible furnaces. The principle of operation and purpose. Various metals and alloys melting features.

12. The basic and structural elements of the induction channel furnace and induction crucible furnace. Advantages and disadvantages. Metal circulation. The calculation of the thermal energy needed to melt the metal (using heat capacity, latent heat of melting, heat content and enthalpy). Performance. Efficiency. Calculation of power.

13. The equations of currents and electric state of induction channel furnaces. The equivalent circuit and the vector diagram of induction channel furnaces.

14. Calculation of the frequency of the supply network for an induction crucible furnace. The choice of a frequency converter and an electric furnace transformer for an induction crucible furnace.

15. The principles of symmetrisation of the single-phase electrical process installations, (the symmetrising Steinmetz scheme, the symmetrical scheme with a reactor divider), the operation of balancing devices under variable load.

16. The purpose and types of reactive power compensation (longitudinal, transverse). Features of compensation of reactive power of electrical process installations.

17. The device providing an electromagnetic impact on liquid metals (pumps, batchers, chutes and devices for electromagnetic mixing of liquid metals).

18. Dielectric heating. The operating principle. The areas of use.

19. Numerical methods for calculating electromagnetic fields. The finite difference method. The finite element method.

20. The Poynting vector in a metallic half-space. Active and reactive power.

21. Resistance of the bus and double-layer conductor to AC.

22. The classification and designation of arc furnaces. Arc steel furnaces, the area of application (basic and acid processes). Basic design elements of arch steel furnaces. A short network of an arc steel smelting furnace.

23. Ore-thermal furnaces. The operating principle. The design features. A short network of ore-thermal furnaces. The features of furnace substations and short networks of ore-thermal furnaces. The design of vacuum arc furnaces with a consumable electrode. Crystallisers. The operational process.

24. Electroslag processes: electroslag melting, surfacing, and welding.

25. The aluminium and copper electrolysis.

26. The electrical methods in dust and gas cleaning systems.

27. The electrical and magnetic methods for the treatment of water systems.

28. The electrical and magnetic methods for the separation of bulk materials.

29. Types of regulators used in the control system of electric resistance furnaces. Their impact on the process quality.

30. Electromagnetic compatibility. The causes of the occurrence, the influence of electric receivers on the operation, measures to reduce the voltage nonsinusoidality.

Subject area: Power electronics

1. The classification of semiconductor electrical power converters. Functions performed by their power unit.

2. Semiconductor rectifiers. Single-phase and multiphase circuits. Their characteristics.

3. The influence of load circuit parameters on the operation of rectifiers. The phase regulation of the rectified voltage.

4. Smoothing filters. Rectifier characteristics when using different filters.

5. Controlled rectifiers.

6. Rectifiers with voltage multiplication.

7. Pulse voltage regulators, i.e. boosting, lowering and inverter.

8. The principles of inverting. Inverters driven by a network (dependent inverter).

9. Stand-alone inverters. Frequency converters with a link to a DC element.

10. Stand-alone power inverters. Output voltage regulation.

11. Stand-alone current inverters. Output current regulation.

12. Resonance converters of the electrical power. Basic schemes and characteristics.

13. The main types of semiconductor switches. Their operating features in direct and alternating current circuits.

14. Thyristor regulators of the alternating voltage

15. Thyristor frequency converters with direct coupling. Reception of low-frequency voltage and current.

16. Methods for regulating the voltage of semiconductor converters.

17. Protection of semiconductor gates against overvoltages.

18. Power factor of semiconductor converters. Ways to improve the power factor.