

# State final exams for the follow-up master's degree program in Electrical Power Engineering

## Compulsory course – Electrical Power Engineering

- Basic Terms from the Field of Protection (definition of protections, classification of protections, requirements for protections, basic elements of protections, dangerous fault conditions in the electrical power system, instrument current and voltage transformers for protections).
- Stage Line Protections (independent, dependent and directional overcurrent protections, undervoltage unblocking of overcurrent independent protections, distance protections).
- Comparative Line Protections (differential transverse and longitudinal protections, compensation of differential measuring elements, phase comparison protections).
- Transformer Protections (differential protection, blocking in case of switching impulse, gas relay, tank protection, transformer backup protections).
- Classical Industrial Heating – resistance, induction, arc (advantages and disadvantages of individual methods of heating, comparison with each other, utilization, problems of connection to the supply network, repercussions on the power supply network and the possibility of their elimination).
- Special Equipment – high frequency, dielectric, microwave, electron, laser (principles, advantages and disadvantages, comparison, utilization).
- Electric Heating (types of heating, their comparison, energy sources, ecological aspects, design of electric heating, issues of heating control).
- Symmetrical Faults (three-phase short circuit in a symmetrical circuit with the resistance and inductance powered by ideal voltage source, short-circuit current waveform, the types of faults, the definitions of basic terms, symmetrical initial short-circuit current, surge short-circuit current, equivalent heating short-circuit current).
- Calculation of Short-Circuit Currents in the General Network (general principles for calculation of short-circuit currents, simplifying assumptions, conditions for calculation of maximum and minimum short-circuit currents, determination of parameters of power system elements, calculation procedure, compilation of replacement schemes, basic relations for calculation).
- Unbalanced Short-Circuits and Ground Faults (symmetrical components method, calculation of short-circuit currents by symmetrical components method for single-phase, two-phase, and two-phase ground fault, comparison of symmetrical and asymmetrical short-circuit currents, ground fault currents and voltages in isolated network, ground fault current compensation).

## Compulsory optional subject – Electricity generation and distribution

- Distribution and Industrial Distribution Systems (power supply system of distribution networks from the transmission system, diagrams of electrical stations, network diagrams, basic concepts of power supply of industrial plants).
- Protection in the Industrial Distribution of Electricity (requirements for protections and circuit breakers, types of protection devices, protection of power lines, electric motors, and other appliances).
- Reactive Power and Voltage Compensation (parallel, serial compensation, vector diagrams, compensation devices).
- Operation of Thermal Power Plants (modern coal and nuclear power plants, steam-gas cycle, cogeneration).
- Alternative Sources (photovoltaics, wind power plants, hydropower plants, electrochemical fuel cells, biomass, energy storage).
- Electrical Part of Power Plants (generators, self consumption, network connection, generator protections).
- Frequency Control (static frequency characteristics of loads and sources - regulating energy, power coefficient, network characteristics of the controlled system – primary, secondary, tertiary control, interaction of primary and secondary control).
- Voltage Control (static voltage characteristics, voltage control at individual voltage levels, reactive power sources, voltage control by reactive power, voltage control by transformers, transformers with transverse and longitudinal control, special transformers for power flow control).
- Reliability of Electricity Supply (numerical expression of reliability, global reliability indicators, methods of reliability calculation, method of reliability schemes).
- Mechanics of lines (types of towers, deflection curve of the conductor, length of the conductor, climatic conditions).

## **Compulsory optional subject – Electrical machines and devices**

- Transient Effect in Electrical Circuit (switching transients, switch-on and switch-off, transient recovery voltage, recovery voltage, influence of transients to design of electrical apparatus)
- Force and Thermal Effect of Electric Current (force effect on straight conductors, force effect on circular loop, special types of force effect, thermal effect of electric current, types of power losses in electrical apparatus, steady-state temperature rise)
- Theory of Switching Process (basic principle of DC current switch-off, types of arc-chutes, basic principle of AC current switch-off, types of arc-chutes, factors influencing of successful switch-off process)
- Protection of Electrical Circuits (Fuses – basic principle and characteristic, current limiting capability of fuse, time-current characteristic, design of LV and MV fuses, slow – S, fast – F and ultra-fast – UF fuses, Circuit breakers – basic principle and design, thermal and, short-circuit release, time current characteristic of circuit breaker, MCB, MCCB, ACB, current limiting circuit breakers)
- Design and Properties of MV, HV, UHV circuit breakers (air-blast, gas-insulated and vacuum circuit breakers, basic principles and design, gas-insulated distribution systems, basic characteristic of switchgears and substations in electric power industry)
- General Principles of Electrical Machines, Basics of Windings (electromagnetic induction, energy conversion, power and efficiency, general electrical machine, windings of electrical machines – diagrams, charts, single-layer and double-layer windings, windings of AC and DC machines).
- Technology of Production and Testing of Electrical Machines (active and construction materials, insulators, technology of winding and magnetic circuit production, machining methods, methods of increasing efficiency, technical documentation, measurement of machine parameters, type, and piece test).
- Transformers and Converters (properties, structural arrangement, nominal values, winding connections, operating and fault states, basic characteristics, replacement diagrams, phasor diagrams. Rotating converters and compensators, cooling systems, operational diagnostics).
- Asynchronous and Synchronous Machines (properties, structural arrangement, types, nominal values, windings, operating and fault states, speed control, basic characteristics, replacement scheme, start-up and phasing procedures, cooling, operational diagnostics).
- Special and Unconventional Electrical Machines (reluctance motors, commutator machines, stepper motors, linear motors, universal actuator, electronically commutated motor, motor systems with converters, construction, operating properties, basic characteristics, control methods, utilization).

## **Compulsory optional subject – Electric light**

- Basics of Eyesight and Vision (eye and visual mechanism, photopic, mesopic and scotopic vision), Light-Technical Quantities and Their Usage in the Design and Operation of Lighting Systems (luminous flux, luminous intensity, illuminance, luminance).
- Light Sources (qualitative and quantitative parameters of light sources) and Luminaires (optical, electrical, and mechanical properties of luminaires, luminous intensity curves, glare reduction principles).
- Maintenance in Lighting and Its Impact on the Lighting Project (behaviour of light sources, luminaires, reflective and transmissive materials during their lifetime, maintained value of illuminance or luminance).
- Daylight and Sunlight (daylight factor, overcast sky, normative requirements).
- Interior Lighting (offices, classrooms, industrial halls - qualitative and quantitative parameters).
- Sport Lighting (outdoor and indoor sports grounds, qualitative and quantitative parameters, requirements on different types and levels of sports).
- Lighting of Outdoor Workspaces and Roads (qualitative and quantitative normative parameters, classification of roads).
- Architectural Lighting and Obtrusive Light (distribution of luminous flux requirements, colour adjustment, environmental zones and resulting requirements).
- Control of Lighting Systems (electronic ballasts, dimmable ballasts, sensors for lighting control, intelligent control systems, public lighting control) and Emergency, Safety and Antipanic Lighting.
- Lighting Measurement (measuring instruments, measurement errors and uncertainties, illuminance measurements, luminance measurements).