

Master of Science in Electrical Engineering
CONTROL IN ELECTRICAL POWER ENGINEERING
List of questions for the Final Examination
In effect since 01.10.2015

1. Numerical and optimization methods:

- a) one-dimensional search methods, golden section search,
- b) unconstrained minimization techniques, the steepest descent method,
- c) nonlinear constrained optimisation, Kuhn-Tucker conditions, Lagrangian function & duality,
- d) penalty methods, linear programming.

2. Power system faults:

- a) identification of faults – basic algorithms for fault detection, fault classification and direction discrimination,
- b) analysis of single phase-to-ground faults in high voltage networks,
- c) characteristic of different methods of neutral earthing in MV networks,
- d) digital fault locators – basics of application, fault location versus protection, application of different input data measurements.

3. Dynamics and control of AC/DC drives:

- a) torque and speed control structures of electrical drives,
- b) speed control methods of converter-fed DC motor drives,
- c) frequency controlled induction motor drives,
- d) artificial intelligence methods in electrical drive.

4. Circuits and systems:

- a) circuits synthesis, positive rational function, immittance function of driving point impedances, Foster synthesis for LC (inductance-capacitance) subclass,
- b) nonlinear circuit analysis, examples of nonlinear characteristic of nonlinear elements, graphical method, series or parallel connection of nonlinear elements,
- c) state variable, definition of state variable, method of system description using state variable, transfer matrix, excitation matrix, output matrix, application of eigen values for stability criterion,
- d) selected issues of continuous representation of deterministic signals, Fourier transform, relation of two-sided Laplace transform, signal parameters in time and frequency domain.

5. Advanced measurements in electrical engineering:

- a) digital to analog and analog to digital converters,
- b) direct measurement methods of high voltages,
- c) indirect measurement methods of high alternating voltage,
- d) types of high voltage dividers, cooperation of capacitive voltage divider with a voltage measuring transformer.

6. Power quality assessment:

- a) power quality disturbances in relations to electromagnetic compatibility, review and classification of power quality disturbances,
- b) voltage fluctuations, definition of the phenomena, method of measurement and algorithm for parameters describing voltage fluctuations, possible origin of the phenomena, potential impact on the operation of electrical power system,
- c) voltage harmonics, definition of the phenomena, method of measurement and algorithm for parameters describing voltage harmonics, possible origin of the phenomena, potential impact on the operation of electrical power system,
- d) power quality report, standards and national regulations for the limits, aggregation time, measurement evaluation.

7. Advanced technology in electrical power generation:

- a) cogeneration systems in energy production,
- b) clean energy production system from fossil fuels – oxyfuel, capture of carbon dioxide,
- c) environmental impact of energy production systems,
- d) nuclear fuel cycle, nuclear fission principles, types of reactors.

8. Electrical power system operation and control:

- a) control of voltage and reactive power in transmission and distribution systems,
- b) excitation and voltage regulation of synchronous generator,
- c) frequency control in power systems - primary and secondary control of frequency in isolated power system,
- d) transient stability of power system - equal area approach.

9. Power system protection:

- a) overcurrent protection, time grading, coordination with fuses,
- b) distance protection of transmission lines,
- c) transformer faults, protection schemes for typical transformers,
- d) busbar protection, basic philosophy, clearance of faults by non-unit circuit protection.

10. Simulation and analysis of power system transients:

- a) digital models of linear elements (R , L , C) of an electric network,
- b) line model with distributed parameters,
- c) single phase saturable transformer model,
- d) numerical stability of digital models - numerical oscillations, suppression/elimination of numerical oscillations.

11. Digital signal processing for protection and control:

- a) Shannon sampling theorem, practical sampling rates,
- b) classification of digital filters, design of recursive and non-recursive filters,
- c) signal magnitude estimation approaches and detailed algorithms,
- d) wide area measurements in power systems.

12. Fiber optics communication and sensors:

- a) fiber classification and design considerations, fiber materials and doping,
- b) semiconductor light sources: light emitting diodes and injection lasers,
- c) fiber optic communication networks, network development, long-haul systems,
- d) optical fiber sensors – classification and application examples.

13. Renewable energy sources:

- a) wind energy productions systems, technical aspects, wind energy markets, future of wind energy,
- b) interconnecting photovoltaic systems to the utility grid,
- c) hydro energy: small and large hydro applications, environmental aspects of small and large hydro,
- d) biomass energy: advantages and disadvantages, European biomass policy.

14. Electrical power systems management:

- a) forms of ownership and management in power systems,
- b) role of the independent system operators in power systems operation,
- c) price mechanism, transmission prices,
- d) system planning under competition, integrated resources planning, demand side management.

15. Power system automation and security:

- a) overvoltage protection in power systems, sources of overvoltages, protection against switching transients,
- b) security problems in MV feeders with no effective earthing,
- c) substation automation and integration,
- d) reasons of wide area developing faults, preventive systems, wide area control, voltage and angle stability monitoring.

16. Electromagnetic compatibility:

- a) sources and parameters of electromagnetic interferences,
- b) electrical equipment and system protection against overvoltages, nonlinear protection elements: gas spark gaps, varistors, diodes, thyristors,
- c) lightning discharges as source of electromagnetic stress,
- d) electromagnetic shielding, effectiveness of shielding from electric and magnetic interference sources in near and far field, low frequency magnetic field shielding,
- e) voltage quality indices and parameters, disturbances influence on power supply system.

17. Artificial intelligence techniques:

- a) expert systems: definitions, knowledge base, data base, inference mechanisms,
- b) ANN architectures and design problems,
- c) fuzzy logic in power system protection: fuzzy criteria signals, fuzzy settings, fuzzy comparison,
- d) genetic algorithms: genetic modifications of individuals, genetic optimisation rules, application examples.

18. Advanced high voltage technology:

- a) gaseous vs. vacuum electrical insulation,
- b) non-destructive test techniques,
- c) optical measurements and monitoring in high voltage environment,
- d) pulsed power – principles and application.