

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

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 quality assessment:
 - a) sources of short interruptions, their influence on equipment, mitigation of interruptions and voltage sags,
 - b) harmonic and inter-harmonic distortions, total harmonic distortion, principles of controlling harmonics, filtering,
 - c) methods and algorithms for PQ monitoring, finding the source of a disturbance,
 - d) flicker causes and effects, mitigation methods.
3. Power system faults:
 - a) equivalent diagrams of power transformers for symmetrical components,
 - b) analysis of single phase-to-earth faults,
 - c) earth faults in networks with isolated neutral point,
 - d) digital fault locators – basics of application, fault location versus protection, application of different input measurements data.
4. 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
5. 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.

6. 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.

7. 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.

8. 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) models of non-linear elements. Solution of the network equations with non-linear elements,
- d) synchronous generator model.

9. 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.

10. 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.

11. 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.

12. Selected problems of circuit theory:

- a) synthesis of multi-poles and multi-ports, synthesis methods, transfer function description,
- b) characteristic phenomena in nonlinear circuits,
- c) nonlinear reactance circuits, ferroresonance, subharmonic oscillations,
- d) stability of nonlinear circuits, local stability analysis.

13. 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.

14. 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.

15. Electromagnetic compatibility:

- a) sources and parameters of external electromagnetic interferences,
- b) low frequency magnetic field shielding, materials for shielding systems, shielding effectiveness,
- c) voltage quality indices and parameters, disturbances influence on power supply system,
- d) electrostatic discharges: characteristics, parameters, remedial measures.

16. 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.

17. 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.

18. 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.