Master of Science in Electrical Engineering
RENEWABLE ENERGY SYSTEMS
List of questions for the Final Examination
In effect since 01.10.2017

1. **Numerical and optimisation methods:**
   a) formulation of an optimisation problem – an example,
   b) iterative search method – gradient method,
   c) necessary and sufficient conditions for a local minimum of an unconstrained problem,
   d) criteria for the termination of an iterative minimization algorithm.

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 engine values for stability criterion,
   d) selected issues of continuous representation of deterministic signals, Fourier transform, relation of two-sides Laplace transform, signal parameters in time and frequency domain.

5. **Measurement methods and techniques**
   a) structures of instrumental amplifiers,
   b) current, voltage and power measurements, geometrical interpretation of power,
   c) A/D and D/A converters uses in signal processing from the renewable energy sources,
   d) smart sensors in distributed systems.

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. **Power electronics:**
   a) 2-, 3- and 6-pulse rectifiers, commutation, output characteristics, advantages and disadvantages of particular solutions,
   b) AC voltage controllers and cycloconverters control systems, common applications,
   c) transistor and thyristor DC-DC switch mode converters,
   d) PWM techniques and their applications.

8. **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.

9. **Protection and control of distributed energy sources:**
   a) distribution networks and generators protection: applied criteria and solution schemes; network earthing issues,
   b) methods for islanding detection: characterization of different criteria used,
   c) protection of photovoltaic sources,
   d) voltage control and stability of distributed generation.

10. **Water power plants:**
   a) types and characteristics of the SHP: Basic types of turbines, turbine technology and parameters,
   b) types and energy parameters of the turbines: Pelton, Banki-Michell, Kaplan, Francis, Kinetic turbines; electrical diagrams,
   c) voltage control in hydro power stations,
   d) project analysis of hydro power stations: analysis of hydrological potential of the site, turbine choice, selection of generator, automation and protection.

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. Integration of distributed resources in power systems:

a) technical requisites for dispersed generators connection to the public electric power grids,
b) dispersed generator contribution to voltage and frequency regulation in electrical power system,
c) impact of dispersed generation on transient processes in electrical power system,
d) the effect of dispersed generators on power quality and reliability of electrical power network.

13. Electromechanical systems in renewable energy:

a) generators driven by high speed and low speed turbines,
b) asynchronous generators with squirrel cage and slip-ring rotors,
c) cylindrical generators with permanent magnet and wounded excitation,
d) disc rotor synchronous generators.

14. 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.

15. Photovoltaic cells:

a) description of the photovoltaic effect, I-V characteristics, cells based on the Schottky barrier,
b) thin film, polycrystalline photovoltaic cells, photovoltaic cells in cadmium telluride,
c) photovoltaic modules, their parameters and characteristics; effect of various factors of the conversion efficiency in photovoltaic cells,
d) photovoltaic power plants; accumulation of electrical energy from photovoltaic modules, concentrating solar power systems.

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, effectives 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. Energy storage systems:

a) classification and main characteristics of different kinds of electrical energy storage in power systems,
b) pumped hydro energy storage,
c) compresses air systems (CAES) and flywheel systems,
d) superconducting Magnetic Energy Storage (SMES), ultra-capacitors.

18. Artificial intelligence techniques:

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