Master of Science in Electrical Engineering
RENEWABLE ENERGY SYSTEMS
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-ground faults,
   c) ground faults in networks with isolated neutral point,
   d) digital fault locators – basics of application, fault location versus protection, application of different input data measurements.
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. 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.

6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.

12. 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.
13. Analog and digital measurement systems:
    a) types of sensors and transducers in measuring systems,
    b) structure, classification and organization of digital measuring systems; functional blocks and their tasks,
    c) A/D and D/A converters uses in signal processing from the renewable energy sources,
    d) digitals systems for wind speed, wave energy and noise measurement.
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) models of non-linear elements. Solution of the network equations with non-linear elements,
    d) synchronous generator model.
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 external electromagnetic interferences; lightning discharges as source of electromagnetic stress,
    b) electrical equipment and system protection against overvoltages, nonlinear protection elements: gas spark gaps, varistors, diodes, thyristors,
    c) electromagnetic shielding, effectives of shielding from electric and magnetic interference sources in near and far field, low frequency magnetic field shielding,
    d) 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,

c) fuzzy logic in power system protection: fuzzy criteria signals, fuzzy settings, fuzzy comparison,

a) genetic algorithms: genetic modifications of individuals, genetic optimisation rules, application examples.