01.10.2020 r.

Master of Science in Electrical Engineering

CONTROL IN ELECTRICAL POWER ENGINEERING

List of questions for the Final Examination

In effect since 01.10.2019

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 instrumentation amplifiers,
   b) 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 production line and 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. 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) differential protection of power 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, antialiasing filtering,
    b) classification of digital filters, design of recursive and non-recursive filters,
    c) algorithms for measurement of signal magnitude, power and impedance components,
    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) 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,
    e) what is the Third Part Acces (TPA) principle?.
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) reasons of wide area developing faults, preventive systems, wide area control,
    d) 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, 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. 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.

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.