Power system transients

Course objectives

To get experience and skills in solving of the influence of non-stationary situations of synchronous machine in symmetrical and asymmetrical transient processes on electric power system, knowledge about transient effects in electric power system.

Content

Lectures:

1. Transient processes occurring in power and electricity systems according to time constants, character of physical and mathematical description and model substitutions of electrical components. Subtransient, electro-magnetic and electromechanical events with practical examples and possibilities of neglecting some physical components for each case.

2. Description of basic electromagnetic processes in three-phase symmetric systems. Analytical solution and introduction of basic parameters of time process - types of substitute effective values and time constants.

3. Solution of failure conditions in topologically complex systems. Introduction of simplifying assumptions, examination of current conditions by the superposition of active fault-free and passive fault network using the system description by the admittance and impedance matrix. Algorithm for voltage state examining before failure.

4. Introduction of the symmetric component systems method for the solution of asymmetric faults in power systems. Specification of the characteristics and parameters of lines, transformers and rotating machines for both the non-rotating and the reverse sequence systems.

5. Application of the method of interconnected symmetric component systems for unbalanced fault problems. Comparison of sizes and time courses of individual types of unbalanced short-circuit currents with three-phase case and each of them mutually. Software solution of component systems method.

6. Specifics of asymmetric transient ratios in systems with isolated and compensated zero point. Detailed analysis of capacitive transients during intermittent earth connections.

7. Mathematical model and phasor diagram of synchronous alternator during electromagnetic and electromechanical transient processes. Transient and subtransient reactance parameters and alternator time constants.

8. Alternator short-circuit state equation, its analytical solution using Park's and Laplace transformations and time-course analysis in the d-q and a-b-c coordinate systems. Breakdown of short circuit current components on stator, excitation and alternator damper according to their frequency and time constants.

9. The concept of active and reactive power transmission stability in the power system. Specifying the stability problem to the SMIB situation of the alternator's cooperation with the large power grid. Electromechanical equations of the system and discussion of its static and dynamic stability.

10. Introduction of dynamic stability criteria of produced active power - method of equivalent energy areas. Analysis of system parameters and active operational activities from a point of view to improve system stability.

11. Detailed investigation of stability by modeling the system and its equation of mechanic movement. Principles of dynamic stability criteria in numerical solution. Software applications suitable for solving electromagnetic transients.

Practicum:

1. Basic elements of the power system, their replacement schemes, technical parameters and the possibility of neglecting partial parameters with respect to the character of the investigated transient process.

2. Identification of replacement schemes parameters of overhead lines, cables, transformers and rotating machines based on technical parameters and basic laboratory measurements.

3. Preparation of complex example of electromagnetic transient solution on transformer. Selection of suitable technical parameters and identification of model parameters.

4. Mathematical differential equations and its analytical solution for transient events corresponding to simplified replacement schemes for operation transformer in no-load and short-circuit states. The obtained results are graphically displayed with the MATLAB tool.

5. Modeling of electro mechanic transient phenomena of synchronous machine in environment of software tool DYNAST