MITSUBISHI ELECTRIC

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Power Systems Engineering Seminar Series

Electromagnetic Transients Analysis Seminar: Modeling and Applications

TOPICS COVERED: The seminar is divided into two parts covering aspects of (1) Modeling power systems for simulation of electromagnetic transients; and (2) Electromagnetic transients analysis applications.

The course is designed to be hands-on at the customer's facilities with the computers and simulation programs (e.g., EMTP or ATP) being provided by the organization being taught this seminar.

1. MODELING POWER SYSTEMS FOR ELECTROMAGNETIC TRANSIENTS ANALYSIS

Summary

- This course covers the theory and mechanics of modeling power systems for use in electromagnetic transients analysis

Goals

- To develop an understanding of theory behind modeling power systems and equipment
- To develop an understanding of the formats for creating models for electromagnetic transient simulations

Course Overview

1. Basic structure of Simulation Program Input Data Files
2. Sources and Equivalents
   - Short-circuit equivalents
   - Generators
3. Modeling Transformers
   - Saturable transformer
   - Detailed matrix representation
   - Ideal transformer
4. Modeling Transformer Saturation
   - Voltage-current curves
   - Flux-current curves
   - Residual flux
   - Hysteresis
5. Modeling Transmission Lines and Cables
   - Lumped-RLC
   - Distributed parameter
   - Detailed electro-geometric representation
6. Modeling Shunt Components
   - Shunt capacitor banks
   - Shunt reactors, including saturation
7. Modeling Series Components
   - Series capacitor, including protection
   - Series reactors
8. Modeling Loads and Power Flow
   - Developing R-L load circuits
   - Steady-state phasor solution
9. Modeling Switches
   - Ideal switch representation
   - Systematic switching
   - Statistical switching
   - Synchronous close implementation
   - Closing resistor implementation
10. Modeling Surge Arresters
    - Ratings
    - Manufacturers data
    - V-I representation for overvoltages
    - V-I representation for energy duty
11. Modeling Instrumentation (PTs, CTs, CCVTs, wave traps)
12. Basic Structure of Simulation Program Output Files
13. Model Verification
    - Voltages (magnitudes, waveshapes)
    - MW and Mvar flows
    - Short circuit duties
    - Connectivity tests
14. Plotting and Interpreting Simulation Program Output

2. ELECTROMAGNETIC TRANSIENTS ANALYSIS APPLICATIONS

Summary

- This segment of the seminar presents electromagnetic transient analysis applications

Goals

- To develop an understanding of the simulation techniques and for application of electromagnetic transients analysis
- To gain experience for the study of power systems transients and to be able to interpret simulation results
- To develop an understanding of various modeling options for power system components to be able to choose appropriate models for specific phenomena
- To gain an understanding of the use of electromagnetic transients simulation results for the specification and design of power system apparatus and overvoltage protection schemes for acceptable system operation

Course Overview

1. Introductory RLC Circuits
2. Transmission Line Energizing and De-energizing Events
   - Fundamental considerations
   - Switching techniques
   - Impact of overvoltages
3. Cable Energizing and De-energizing Events
   - Fundamental considerations
   - Switching techniques
   - Impact of overvoltages
4. Capacitor Bank Energizing and De-energizing Events
   - Current limiting reactor size (inrush and outrush currents)
   - Switching techniques
   - Impact of overvoltages
   - Voltage magnification
5. System Faults
   - Fault inception and clearing events
   - Representation of system operating philosophies
   - Stuck breaker scenarios
   - Impact of overvoltages and inrush currents
6. Transformer Energizing Events
   - Impact of saturation, residual flux, and hysteresis
   - Switching techniques
   - Impact of overvoltages and inrush currents
7. Transient Recovery Voltages (TRV)
   - ANSI/IEEE/IEC Standards related to TRV
   - Impacts on system and circuit breakers
   - Influence of substation equipment and buswork
   - Mitigating TRVs
   - Interpreting results and practical concerns
8. Lightning Surge Analysis of Air-Insulated Substations
   - Modeling substation equipment
   - Modeling the lightning stroke
   - Impact of overvoltages
   - Insulation coordination
9. Lightning Surge Analysis of Gas-Insulated Substations
   - Modeling the GIS
   - Modeling the connected air-insulated substation equipment
   - Modeling the lightning stroke
   - Impact of overvoltages
   - Insulation coordination

WHO SHOULD ATTEND: Engineers working with power systems in the electromagnetic transients area. Prior formal experience with electromagnetic transient simulations is not required.

LENGTH: This hands-on seminar is designed to be presented in 2 weeks (1 week for each part). A reduced version of this course can be designed if only a subset of the topics are of interest.

FEATURES

- 2-speakers for the selected seminar duration
- All seminar notes and supporting technical papers in binders for each participant (several hundred pages)
- Numerous sample data files

CONTACT FOR MORE INFORMATION

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