POWERFACTORY

Electromagnetic Transient Analysis

S2021.03.17.Online_EMT.En

March 17th - March 19th 2021

Online training course

The course gives an overview of electromagnetic transients in power systems and the simulation techniques available in *PowerFactory* for their assessment. As such, it provides the participant with the necessary background to understand complex transient mechanisms in the power systems while emphasising the models required for EMT-type simulations.

The training introduces the different transient categories, from temporary, over switching up to lightning transients, in the sequence typically required for an insulation coordination study. Besides the review of the theoretical fundamentals, multiple handson exercises will assist the participant to familiarise with the EMT-simulation in *PowerFactory*.

WHO SHOULD ATTEND:

The course is intended for

- Utility engineers
- Power system operators
- Project Developers
- Manufacturers
- Consultants
- Electrical engineers in general

Participants should be familiar with *PowerFactory* basics and should have some experience with *PowerFactory*'s time domain simulation functions or have attended the equivalent introductory courses ("Time Domain Simulation in *PowerFactory*", "Load Flow and Short Circuit Calculation").

PRICE PER PARTICIPANT:

- 1,674.00€* (with valid maintenance contract)
- 1,905.00€* (without valid maintenance contract)
- 570.00€* (with valid student identification)

*Prices are exclusive of VAT

Training schedule

Central European Time (UTC +01:00)

DAY 1

9:00 Introduction to Electromagnetic Transients
Transient phenomena in power systems. Classification of overvoltages acc. to IEC60071: temporary, slow-front, fast-front and very fast-front transient overvoltages. RMS versus EMT simulations. The EMT solver in PowerFactory. Handling: definition of simulation events and result variables. Visualisation of simulation results. Fast Fourier analysis.

10:00 Transformer energisation
Fundamentals. Transformer inrush current. Saturation characteristics. Residual flux. Harmonic content of inrush currents. Resonance overvoltages excited by inrush currents.

10:30 Coffee break

11:00 Exercise: Transformer Energisation
Energisation of a transformer in a weak network. Determination of maximum inrush current. Decaying DC component. Voltage dip during energisation. Assessment of typical grid code compliance. Mitigation of inrush currents. Conversion RMS to peak values.

12:30 Lunch break

13:30 Capacitor Switching
Fundamentals. Inrush current and switching overvoltage during energisation of capacitor banks. Back to back connections. Mitigation of inrush currents.

15:00 Coffee break

15:30 Exercise: Filter Bank Energisation
Natural oscillation frequencies. Simulation of inrush currents and maximum transient overvoltages in a filter bank. Back-to-back energisation of a second filter bank.

17:00 End of the first day

DAY 2

9:00 Transient Recovery Voltage (TRV) Analysis
Fundamentals. Overview of abnormal switching transients, trapped energy and current chopping. Dielectric strength of circuit breaker after contact opening. Suppression (or chopping) and recovery overvoltages. Voltage escalation following abnormal switching.

10:30 Coffee break

11:00 Exercise: TRV Analysis for Shunt Reactor Drop Out
Assessment of switching overvoltages due to reactor drop out. Vacuum circuit breaker model. Current chopping.

12:30 Lunch break

13:30 Overhead Line and Cable Models for EMT-Simulations
Overhead line models and cable systems. Lumped and distributed parameter models. Constant and frequency dependent parameters. Travelling wave effects.

15:00 Coffee break

15:30 Exercise: Modelling of Overhead Lines and Cable Systems
Definition of overhead line and cable systems. Analysis of lumped and distributed parameter line models. Comparison of constant and frequency dependant parameters.

16:30 Line switching
Line energisation: maximum transient overvoltages. Deterministic and stochastic assessment. Overvoltage mitigation: surge arresters and pre-insertion resistors. Protection characteristics. Energy duty.

17:00 End of the second day

DAY 3

9:00 Exercise: Assessment of Switching Overvoltages in a Mixed OHL/Cable System
Maximum transient overvoltages based on deterministic and stochastic approach. Modelling of surge arresters and pre-insertion resistors. Stochastic switching.

10:30 Coffee break

11:00 Lightning Transients
Fundamentals of transient phenomena and its interaction with the power system. Modelling of relevant power system components for lightning transient analysis: impulse sources, line/cable surge impedances, tower footing resistance, dielectric strength of isolators. Surge arresters. Stray capacitance of transformers.

12:30 Lunch break

13:30 Exercise: Model Enhancement fo Lightning Analysis
Defintion of the overhead line model for lightning analysis. Phase conductors and earth wires. Line couplings. Model of the footing resistance. Voltage controlles switches to represent the flashover. Impulse current sources.

15:00 Coffee break

15:30 Exercise: Assessment and Mitigation of Lightning Overvoltages
Determination of the lightning performance of a transmission line. Simulation of direct and earth wire strikes. Back flashover. Overvoltage mitigation: selection of surge arresters. Lightning protection characteritic. Energy duty. Lightning overvoltages under consideration of surge arresters.

17:00 End of the training course

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