Training Content

Power System Stability

DAY 1

MODULE 1: Introduction to Power System Stability

Presentation: Introduction and Basic Concepts — **3/4 h**

Fundamentals of power system stability. Classification according to IEEE: rotor angle, voltage and frequency stability. Synchronous machine model.

MODULE 2: Transient Stability Analysis

Presentation: Rotor Angle Stability - Transient Stability — **3/4 h**

Fundamentals of transient stability. Equal Area Criterion. Methods for improving transient stability problems.

Coffee break

Exercise: Transient Stability in a SMIB — **1 1/2 h**

Studies in a Single-Machine-Infinite-Bus. Critical clearing time calculation. Visualisation and analysis of results. Effect of changing the initial point of operation.

Q&A session

DAY 2

Exercise: Transient Stability in a Multi-Machine Network — **1 1/2 h**

Critical clearing time calculation using a DPL script. Effect of the inertia and the impedance of the system on the transient stability problems. Calculation of the static and dynamic transfer limits.

Coffee break

MODULE 3: Oscillatory Stability (Small Signal) Analysis

Presentation: Rotor Angle Stability - Oscillatory Stability — **1 1/2 h**

Description of the linearisation methods. Oscillatory stability in time and frequency domain analysis. Modal analysis and eigenvalue plot. Methods to improve small signal stability.

Q&A session

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DAY 3

Exercise: Oscillatory Stability in a SMIB — **1 ½ h**

Identification of the local mode of a single machine connected to an infinite bus. Analysis done in time and frequency-domain. Impact of the AVR and PSS.

Coffee break

Exercise: Oscillatory Stability in a Multi-Machine Network — **1 ½ h**

Identification of critical oscillation modes in a multi-machine network using modal analysis. Evaluation of the type of oscillation (local, inter-area). Methods to efficiently increase the damping. Impact of different network configurations on the oscillation modes.

Q&A session

DAY 4

MODULE 4: Voltage Stability Analysis

Presentation: Voltage Stability — **¾ h**

Fundamentals. Causes and contributing factors in voltage stability problems. Classification of the voltage stability and tools used in every case: steady state and dynamic.

Exercise: Steady State Voltage Stability. Part 1 — **¾ h**

Calculation of busbars sensitivities, PV curves considering contingencies, effect of modifying the load and replacing conventional generation by renewable generation and a HVDC link.

Coffee break

Exercise: Steady State Voltage Stability. Part 2 — **½ h**

QV curves considering contingencies and effect of modifying the load.

Exercise: Dynamic Voltage Stability — **1 h**

Study of voltage stability in the time domain analysis, RMS simulation. Effect of the load modelling and power electronics, motors contribution and AVR dynamic response.

Q&A session

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DAY 5

MODULE 5: Frequency Stability Analysis

Presentation: Frequency Stability — 1 ½ h

Fundamentals. Definition of the different stages of the frequency stability analysis and factors contributing in each stage: inertia, regulation actions and primary reserve, under-frequency load shedding.

Coffee break

Exercise: Frequency Stability in a Multi-Machine Network — 1 ½ h

Frequency stability after generators outages. Effect of primary control, load modelling, replacement of conventional generation by renewable generation, a HVDC link and a Battery Energy Storage System, areas separation and load shedding. Comparison between different methods to improve frequency stability.

Q&A session

Time Schedule (Central European Time)

	Time
First 90 minutes block	9:00
Coffee break	10:30
Second 90 minutes block	10:45
Q&A session	12:15
End of the training day	12:30

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