

# 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

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### 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 1/2 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 1/2 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

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## DAY 4

### MODULE 4: Voltage Stability Analysis

#### Presentation: Voltage Stability

3/4 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

3/4 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

1/2 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 1/2 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 1/2 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

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## Time Schedule (Central European Time)

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



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