

**Module Description, available in: EN**

## *Power Grids: Systems and Devices*

**General Information****Number of ECTS Credits**

3

**Module code**

TSM\_PowGrid

**Valid for academic year**

2020-21

**Last modification**

2019-10-11

**Coordinator of the module**Adriano Nasciuti (SUPSI, [adriano.nasciuti@supsi.ch](mailto:adriano.nasciuti@supsi.ch))**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne	Lugano	Zurich
<b>Instruction</b>	X E 100%		X E 100%
<b>Documentation</b>	X E 100%		X E 100%
<b>Examination</b>	X E 100%		X E 100%

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

**Entry level competences****Prerequisites, previous knowledge**

Basics of electrical laws, circuitries, components in power grids, energy conversion, electric charge, electric field, as well as of ordinary and partial differential equations expected.

**Brief course description of module objectives and content**

In this module, students will increase their knowledge in selected areas of power grids in electricity distribution and transmission:

- high voltage engineering and relevant design problems
- learn the origin of networks failures, consequences, preventing and recovery measures
- design, construction and parameters of components in power grids
- organization of voltage and power regulation in interconnected grid
- math. analyze and control in power grids
- special actual problems in TD (transmission and distribution)

## Aims, content, methods

### Learning objectives and competencies to be acquired

#### Students

- know the main challenges of today's modern grids
- know the main elements of an electrical grid and the differences of transmission components
- possess a fundamental knowledge of the principles of designing high voltage equipment.
- Know the basic design and technical solutions of the most important high voltage equipment in a power grid
- have become acquainted with the static/dynamic modelling and simulation of high voltage components.
- know how to design power grids
- know how to perform basic grid calculations
- know the behavior of meshed grids in normal operation
- know the DC transmission technology
- can describe the advantages of smart-grid applications for the DSOs
- learn the basic principles of the management and regulation of electrical grids

### Module content with weighting of different components

Course	Designation	
0	<p><b>Introduction: Evolution of the power grid</b></p> <p>Technological milestones, DC and AC Systems, components and devices, mathematical methods for AC grid analyze, basics of energy policy modern grids.</p> <p>Week 1</p>	
1	<p><b>Fundamentals high voltage engineering</b></p> <ul style="list-style-type: none"> <li>• Tasks of HVE, Overvoltages origin and control insulation Coordination (w2)</li> <li>• Properties of insulating materials (w2)</li> <li>• Electric fields and field stress control, (w3-4)</li> <li>• Break down in gases (homogeneous field – Paschen; inhomogeneous field – Streamer/Leader (w5)</li> <li>• Exercises</li> </ul> <p>Weeks 2,3,4,5</p>	
2	<p><b>HV-devices (cables, circuit breakers, surge arresters, ...)</b></p> <ul style="list-style-type: none"> <li>• Cable termination (HV-Cables)</li> <li>• Nonlinear (semi-conductive) insulation materials (surge arresters?)</li> <li>• Circuit breaker technologies</li> </ul> <p><b>Non destructive Insulation testing</b></p> <ul style="list-style-type: none"> <li>• Dielectric measurements</li> <li>• Partial Discharge measurements and diagnosis</li> </ul> <p>Weeks 6,7</p>	
3	<p><b>Interconnected Grids</b></p> <ul style="list-style-type: none"> <li>• Design and operation of T&amp;D Grids</li> <li>• Frequency &amp; active power exchange under control of the TSO</li> <li>• Combined voltage and reactive power control in the T&amp;D Grid</li> <li>• <b>Excursion Swissgrid Control Center, Aarau / W.Sattinger</b></li> </ul> <p>Weeks 8,9,10</p>	
4	<p><b>Special Chapters on T&amp;D (Transmission and Distribution)</b></p> <ul style="list-style-type: none"> <li>• Power Quality phenomena: PQ-Standards and their application in the grids</li> <li>• Optimized Grid use by “Smart Grid” Applications</li> <li>• Cables and overhead lines: visibility versus costs and efforts</li> <li>• Power Generation: Synchronous machines and Converters</li> <li>• HVAC transmission or DC Supergrid</li> <li>• Communication over the power grid</li> <li>• ...</li> </ul> <p>Weeks 11,12,13,14</p>	

### Teaching and learning methods

- ex cathedra teaching
- exercises
- presentation and discussion of case studies

## Literature

A. KÜchler; «High Voltage Engineering», Springer Vieweg (2018)

Information on additional literature will occasionally be given during the module.

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

1 online revision test towards the end of the module has to be done and accepted for admission to the final examination (only admission condition but not part of the final grading).

### Basic principle for exams

**As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.**

### Standard final exam for a module and written resit exam

#### Kind of exam

Written exam

#### Duration of exam

120 minutes

#### Permissible aids

*Aids permitted as specified below:*

#### Permissible electronic aids

- Electronical aids: calculator

#### Other permissible aids

- Hardcopy form: 2 A4 double-sided pages summary are permitted

### Special case: Resit exam as oral exam

#### Kind of exam

Oral exam

#### Duration of exam

30 minutes

#### Permissible aids

No aids permitted