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

Last modification

2019-10-11

Coordinator of the module

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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.

	Berne	Lausanne			Lugano	Zurich		
Instruction		**X** E 100%				**X** E 100%		
Documentation		**X** E 100%				**X** E 100%		
Examination		**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 acquired competencies

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

Contents of module with emphasis on teaching content

Course	Designation	
0	**Introduction: Evolution of the power grid** Technological milestones, DC and AC Systems, components and devices, mathematical methods for AC grid analyze, basics of energy policy modern grids. Week 1	
1	**Fundamentals high voltage engineering** • Tasks of HVE, Overvoltages origin and control insulation Coordination (w2) • Properties of insulating materials (w2) • Electric fields and field stress control, (w3-4) • Break down in gases (homogeneous field – Paschen; inhomogeneous field – Streamer/Leader (w5) • Exercices Weeks 2,3,4,5	
2	**HV-devices (cables, circuit breakers, surge arresters, …)** • Cable termination (HV-Cables) • Nonlinear (semi-conductive) insulation materials (surge arresters?) • Circuit breaker technologies **Non destructive Insulation testing** • Diectric measurements • Partial Discharge measurements and diagnosis Weeks 6,7	
3	**Interconnected Grids** • Design and operation of T&D Grids • Frequency & active power exchange under control of the TSO • Combined voltage and reactive power control in the T&D Grid • **Excursion Swissgrid Control Center, Aarau / W.Sattinger** Weeks 8,9,10	
4	**Special Chapters on T&D (Transmission and Distribution)** • Power Quality phenomena: PQ-Standards and their application in the grids • Optimized Grid use by “Smart Grid” Applications • Cables and overhead lines: visibility versus costs and efforts • Power Generation: Synchronous machines and Converters • HVAC transmission or DC Supergrid • Communication over the power grid • … Weeks 11,12,13,14	

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 the standard final exams for modules and also all resit exams are to be in written form

Standard final exam for a module and written resit exam

Kind of exam

written

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

Duration of exam

30 minutes

Permissible aids

No aids permitted