

EE-362

**Power systems analysis**

Paolone Mario

<b>Cursus</b>	<b>Sem.</b>	<b>Type</b>
Electrical and Electrotechnical Engineering	BA5	Opt.
Energy Science and Technology	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	During the semester
Workload	150h
Weeks	14
<b>Hours</b>	<b>5 weekly</b>
Lecture	3 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

The course provides the fundamental concepts to model power systems, understand their operation and design/coordinate some of its main components.

**Content**

1. Introduction to power systems
  - Structure of power systems
  - Classification as a function of the rated voltage
  
2. Recall of fundamental principles for the analysis of AC circuits and systems
  - Recall of fundamentals aspects for the study of AC circuits: phasors, instantaneous powers, AC powers
  - Recall of fundamentals aspects for the study of AC three phase circuits
  - Study of unsymmetrical three phase circuits: the symmetrical component analysis
  
3. Elements of transmission lines for the transportation of electricity
  - Derivation of transmission lines equations from electromagnetic field theory
  - Transmission lines modeling
  - Expressions of electrical power flows in AC transmission lines
  - Numerical simulation of transmission lines
  - Heat balance of overhead transmission lines and cables
  - Thermal behaviour in case of overloading and short circuit
  - Design principles of transmission lines and cables
  
4. Fundamentals of electrical machines
  - Magnetic circuits and operation of transformers
  - Transformers equivalent circuits and parameters derivation
  - Rotating synchronous machines: operation and equivalent circuit
  
5. The power flow problem

- From the physical network to the admittance matrix (nodal analysis in steady state conditions)
- Formulation of the power flow problem in cartesian and polar coordinates
- Numerical solution of the power flow problem
- Applications of the power flow to analyse the behaviour of power systems

#### 6. Short circuit analysis and protections

- Electromagnetic transients associated to short circuits
- Breakers characteristics and their selection
- Computation of symmetrical and unsymmetrical short circuit currents using the symmetrical components analysis
- Protections against short circuits and relays coordination
- Short circuit behaviour of systems with grounded/ungrounded neutral
- Protections of systems with grounded/ungrounded neutral

#### 7. Frequency regulation in power systems

- Power balance and frequency in power systems
- Primary frequency control
- Secondary frequency control
- Dynamic simulation of power systems

### Keywords

Power systems, transmission lines, power flow analysis, symmetrical components analysis, admittance matrix calculus, short circuit analysis, protections and relaying, power systems dynamics, frequency control.

### Learning Prerequisites

#### Required courses

Electrical circuits and systems, fundamental of signal processing.

### Learning Outcomes

By the end of the course, the student must be able to:

- Assess / Evaluate the behavior of power systems
- Design parts of power systems and/or sub-systems
- Develop models of power systems in steady state
- Develop models of power systems in transient conditions
- Analyze the static and dynamic behavior of power systems
- Produce models of power systems
- Justify power systems design choices

### Teaching methods

Ex cattedra lectures, numerical exercises and simulations on dedicated software.

### Expected student activities

Students are expected to attend lectures, participate in exercise sessions (which include numerical exercises and simulations using dedicated software), and complete tests throughout the semester.

### Assessment methods

The course grade is based on tests conducted during the semester and a final exam.

### Resources

#### Virtual desktop infrastructure (VDI)

Yes

#### Moodle Link

- <https://go.epfl.ch/EE-362>

### Prerequisite for

EE-472 Smart grids technologies