Course guide
295322 - 295SE012 - Distributed Generation and Transmission of Electrical Energy

Last modified: 12/06/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: MASTER'S DEGREE IN TECHNOLOGIES FOR DISTRIBUTED ENERGY SYSTEMS (Syllabus 2025). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Eduard Bullich Massagué

Others: Eduard Bullich Massagué
Juan José Mesas García

PRIOR SKILLS

Calculations with complex numbers. Knowledge of three-phase systems, control, and optimization

LEARNING RESULTS

Knowledges:
K4. Identify methods for studying the environmental impact of a distributed electricity system with renewable sources and relate it to the decarbonisation of energy generation.
K1. Identify renewable resources as sources of electrical energy.

Skills:
S3. Assess the impact and needs of new electricity consumption models and relate them to the change in energy model resulting from the decarbonisation of energy sources.
S2. Analyse the electronic subsystems required in a renewable energy plant and evaluate automation and control technologies for energy management of smart electrical grids and microgrids in a decentralised energy system.

Competences:
C3. Develop the ability to evaluate inequalities based on sex and gender to design solutions that resolve them.
C1. Integrate the values of sustainability and understand the complexity of systems, with the aim of undertaking or promoting actions that restore and maintain the health of ecosystems and improve justice, thereby generating visions of sustainable futures.
C2. Identify and analyse problems that require making autonomous, informed and reasoned decisions in order to act with social responsibility following ethical values and principles.

TEACHING METHODOLOGY

The course uses an expository methodology for 20%, laboratory work for 20%, and individual self-directed learning for 60%.

LEARNING OBJECTIVES OF THE SUBJECT

Understand the behavior of electrical distribution networks.

Understand the challenges of integrating distributed generation into electrical networks.

Learning optimization tools. In this course, the focus is on optimizing the operation of electrical networks, but the tools can be applied to other fields as well.

Knowledge of regulations related to control actions of distributed (and non-distributed) generation plants, as well as the rationale behind these regulations (i.e., the challenges they address).

Understanding how to comply with regulations for the integration of distributed generation.

STUDY LOAD

Type	Hours	Percentage
Self study	94,0	62.67
Hours small group	28,0	18.67
Hours large group	28,0	18.67

Total learning time: 150 h

CONTENTS

Modeling and analysis of electric power transmission and distribution networks

Description:
- Introduction: Structure of the electrical system
- Modeling of transmission and distribution lines and transformers
- Steady-state analysis of electric power transmission and distribution lines.
- Load flow study of electrical networks
- Load flow practice with Matlab-MATPOWER: distribution network with distributed energy resources

Specific objectives:
Understand the electric power transmission and distribution system, how a power line and an electric network behave, and the challenges that arise with the integration of distributed energy resources

Related activities:
Practical exercise related to the modeling of a distribution network, its analysis, and the proposal of improvements.
Depending on ENDESA's availability, there may be a possibility to organize a visit to the distribution network control center of Catalonia, as well as to an electrical substation. If the activity takes place, it would be outside of class hours and completely voluntary.

Full-or-part-time: 53h 40m
Theory classes: 10h
Practical classes: 10h
Self study : 33h 40m

title english

Description:
• Access and connection conditions to the grid
• Introduction to the integration of renewables into the electrical grid
• European regulation and standards for generator integration
• Control of distributed generation plants for grid integration
• Practice with Matlab-Simulink: active power control of a photovoltaic generation plant

Specific objectives:
Understand the control functions required (and the reasons for these requirements) in generation plants, with special emphasis on distributed generation (wind, photovoltaic, etc.), in order to properly integrate them into the electrical grid. Understand the structure of a photovoltaic generation plant and how to control it. The concepts learned will be applicable to other technologies such as wind power.

Related activities:
Practice with Matlab-Simulink: active power control of a photovoltaic generation plant

Full-or-part-time: 42h 40m
Theory classes: 8h
Practical classes: 8h
Self study : 26h 40m

Optimization of the operation of distributed electric power systems

Description:
• Introduction to optimization
• Mathematical formulation of an optimization problem for radial distribution networks
• Convexification and solution of the optimization problem
• Practice with GAMS software: optimization of the operation of a distribution network

Specific objectives:
Learn to formulate an optimization problem to operate a distribution electric network with distributed energy resources. Become familiar with the formulation of an optimization problem

Related activities:
Practice with GAMS software: optimization of the operation of a distribution network

Full-or-part-time: 53h 40m
Theory classes: 10h
Practical classes: 10h
Self study : 33h 40m

GRADING SYSTEM

The evaluation will be carried out based on the teacher's evaluation. During the course, three practical assignments will be completed, accounting for 75% of the final grade, and a presentation at the end of the course will account for the remaining 25%. This course does not include a resit exam.

BIBLIOGRAPHY

Basic:
- Ramírez Rosado, Ignacio J. Problemas resueltos de sistemas de energía eléctrica. Madrid: Thomson, cop. 2007. ISBN 9788497324083.
- Bergen, Arthur R. Power systems analysis. 2nd ed. Upper Saddle River, N.J: Prentice-Hall, cop. 2000. ISBN 0136919901.
- Elgerd, Olle Ingemar. Electric energy systems theory : an introduction. 2nd ed. New York [etc.]: McGraw-Hill, cop. 1982. ISBN 0070192308.
- Glover, J. Duncan; Sarma, Mulukutla S. Power system analysis and design : with personal computer applications. 2nd ed. Boston: PWS Publishing Company, 1994. ISBN 0534939600.
- Ras i Oliva, Enric. Teoría de líneas eléctricas : de potencia, de comunicación, para transmisión en continua. Barcelona: Universidad Politécnica. ETS Ingenieros Industriales, DL 1973-1975. ISBN 8460066819.