COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2024 - 2025

GENERAL INFORMATION

Data of the subject	
Subject name	Electric power systems
Subject code	MEPI-512
Mainprogram	Máster Universitario en Sector Eléctrico / the Electric Power Industry por la Universidad Pontificia Comillas
Involved programs	Master in the Electric Power Industry [First year]
Level	Postgrado Oficial Master
Quarter	Semestral
Credits	6,0 ECTS
Type	Obligatoria
Department	Department of Electrical Engineering
Coordinator	Francisco Miguel Echavarren Cerezo
Schedule	Lunes y miércoles de 19 a 21 horas
Office hours	Student must ask for an appointment by sending an email

Teacher Information	
Teacher	
Name	Francisco Echavarren Cerezo
Department	Department of Electrical Engineering
Office	Francisco de Ricci, 3 [D-104]
EMail	Francisco.Echavarren@iit.comillas.edu
Phone	4283
Teacher	
Name	Mohammad Rajabdorri
Department	Instituto de Investigación Tecnológica (IIT)
Office	Santa Cruz de Marcenado 26
EMail	mrajabdorri@comillas.edu
Phone	4524

DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

Linear algebra and calculus.

Course contents

Contents

Part I: Introduction to Power Systems

Chapter 1. Physical and Functional Structure of Electric Power Systems

1. Demand
2. Generation
3. Transmission and Distribution
4. Market Operation and System Operation
5. Retailing

Chapter 2. Functional Description of Electric Power Systems

1. Time Scales
2. Expansion Planning
3. Operation Planning
4. Operation
5. Supervision and Control
6. Protection

Chapter 3. Future Trends

1. New Transmission and Distribution Technologies
2. Integration of Renewable Energy Sources
3. Smart Grids

Chapter 4. Power System Basic Analysis Tools

1. DC Circuits Review
2. Single-phase AC Circuits Review
3. Three-phase AC Systems
4. Per unit magnitudes

Part II: Technical analysis of power systems

Chapter 5. Frequency control

1. Principles of control systems
2. Principles of frequency control
3. Primary regulation
4. Secondary and tertiary regulation

Chapter 6. Voltage control

1. Principles of voltage control
2. Voltage control of transmission lines
3. Voltage control by generator excitation

4. Voltage control by ULTC transformers

Chapter 7. Power flow

1. Models of power system components
2. Network model
3. Formulation of power flow problem
4. Solution by Newton's method
5. DC power flow
6. Contingency analysis by DC power flow
7. Optimal power flow

Laboratory session # 1. Frequency control

Load regulation. Primary regulation. Secondary regulation.

Laboratory session # 2. Voltage control

Voltage control of a synchronous generator at open circuit. Voltage control of a synchronous generator connected to an infinite grid by excitation control and by transformer tap control.

Laboratory session # 3. Power flow

AC power flow data structure and solution. Generator voltage control. Contingency analysis. Optimal power flow.

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
The exams are a combination of a multi-option test and problems.	The weighted grade of the exams must be greater or equal to 5.	90
There are 3 assignments that the students can be done in groups following the instructions of the professor.	Assignments will be evaluated by discussing with the professor the student reports through an interview.	10

Grading

REGULAR ASSESSMENT

The theory will account for 90% of the grade, of which:

- 1st Exam: Power system structure & functional description up to medium-term decisions (13/60)
- 2nd Exam: Functional description & DC-AC circuits & Three Phase Systems (13/60)
- 3rd Exam: Frequency control (10/60)
- 4th Exam: Voltage control (14/60)

- 5th Exam: Power flow (10/60)

The weighted grade of the exams must be greater or equal to 5.

The exams are a combination of a multi-option test and problems.

Assignment evaluation will account for the remaining 10%. There are 3 assignments that the students can be done in groups following the instructions of the professor: frequency control, voltage control, and power flow. Assignments will be evaluated by discussing with the professor the student reports through an interview.

RETAKE

A single retake final exam will account for 90% of the grade.

The grade of the exam must be greater or equal to 5.

Assignment evaluation carried out in the regular assessment will account for the remaining 10%.

COURSE RULES

Class attendance is mandatory according to Article 93 of the General Regulations (*Reglamento General*) of Comillas Pontifical University and Article 6 of the Academic Rules (*Normas Académicas*) of the ICAI School of Engineering. Not complying with this requirement may have the following consequences:

- Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.
- Regarding laboratory, absence to more than 15% of the sessions can result in losing the right to take the final exam of the regular assessment period and the retake. Missed sessions must be made up for credit.

Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (*Reglamento General*) of Comillas Pontifical University).

BIBLIOGRAPHY AND RESOURCES

Basic References

- D. Laloux & M. Rivier, "Technology and Operation of Electric Power Systems", in Regulation of the Power Sector, J.I. Pérez Arriaga, Ed. (p. 1-46), Springer, 2013.
- A. Gómez Expósito, A. J. Conejo, C. Cañizares, Electric Energy Systems: Analysis and Operation, CRC Press, 2009.