GENERAL INFORMATION

Course information	
Name	Current Developments in Power Systems
Code	DIE-OPT-629
Degree	MII, MIT, SAPIENS program
Year	2nd
Semester	2nd (Spring)
ECTS credits	6 ECTS
Type	Elective
Department	Electrical Engineering
Area	
Coordinator	Rafael Cossent
Profesores	Rafael Cossent, Andrés Ramos, Luis Olmos, Javier García, Pablo Frías, Pablo Rodilla, Carlos Batlle, Paolo Mastropietro, José Pablo Chaves, Javier Matanza, Carlos Rodríguez-Morcillo, Sadot Alexandres, Jaime Boal, Andrés González, Lukas Sigrist, Paloma Cucala

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DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

Despite the fact that electric power systems as we know them nowadays have been in operation for several decades, they are continuously evolving in order to address the new challenges they need to respond to.

In this course, students will receive an overview of the most recent developments in the different areas related to power systems, leveraging on the results of recent and ongoing research and consultancy projects developed for and in collaboration with the industry, regulators and policy-makers.

Prerequisites

A general background of power systems is required.
Capacity to understand and express oneself in oral and written English.

CONTENTS

Contents
The course is structured into different modules. Each one of them addresses a specific topic by presenting, using real-life examples, the current challenges, the needs identified by the different stakeholders involved and the solutions proposed and implemented. Modules are grouped into four blocks as described below.
Block 1 – Introduction. Transmission networks
1. Introduction
Overview of the whole course and introduction to the minimum level of knowledge required to follow the subsequent modules: current power systems operation and management, driving forces for the new developments in power systems, overview of existing challenges, and identification of relevant stakeholders.
2. Coordinated transmission expansion planning
Coordinated transmission and generation expansion planning with application to the European contexts: challenges, needs, models and results.
3. Planning and application of HVDC transmission supergrids
Development and operation of HVDC "supergrids" on top of existing AC transmission networks in a market environment: drivers, challenges, modelling needs and market design.
Block 2 – Energy markets and capacity mechanisms
4. Electricity market design under larges shares of intermittent generation
Electricity market design to support an efficient integration of renewable energy in the European system: policy targets, role of market design, day-ahead, intraday, balancing markets.
5. Design of capacity mechanisms under different generation capacity structures
Drivers for the implementation of capacity mechanisms in different power systems, existing schemes and challenges faced. Recent experiences from Europe, Asia and Latin America.
Block 3 – Smart grids, smart cities, smart buildings
6. Smart distribution systems
Towards a largely distributed power system with an increasing role for distribution networks. Recent experiences from demonstration projects in Europe and the US and mechanisms to leverage on their results for a large-scale deployment.
7. Communication systems applied to electricity networks
New roles of ICTs in the power system: use of PLC and wireless communications applied to power systems, particularly smart distribution grids and smart homes.
8. Energy management in smart cities and smart homes
Tools and applications to manage energy consumption in smart homes with the presence of renewables and storage systems. Application to the Spanish residential sector.
Block 4 – Universal access, microgrids, isolated systems and railway systems
9. Rural electrification and universal access
Achieving sustainable and affordable universal access to electricity supply in developing countries: challenges, modelling needs for planning, regulation and policymaking to support large-scale expansion of stand-alone, microgrids or grid extension supply, enabling sustainable business models that answer to the social, environmental and financial characteristics of these communities. Some recent experiences in India, Latin America and Africa.

10. Operation of small isolated power systems
Power system stability and control in small isolated power systems such as microgrids or islands: challenges, protection and control systems, and cost minimization.
11. Enhancing energy efficiency in railway systems
Technical solutions and operation strategies to enhance energy efficiency in railway systems subject to comfort and scheduling constraints. Experiences in subway and high speed railway lines.

Competences

General competences

CG4. Capacidad de resolver problemas con iniciativa, toma de decisiones, creatividad, razonamiento crítico y de comunicar y transmitir conocimientos, habilidades y destrezas en el campo de la Ingeniería Industrial.

CG5. Conocimientos para la realización de mediciones, cálculos, valoraciones, tasaciones, peritaciones, estudios, informes, planes de labores y otros trabajos análogos.

CG6. Capacidad del manejo de especificaciones, reglamentos y normas de obligado cumplimiento.

CG7. Capacidad de analizar y valorar el impacto social y medioambiental de las soluciones técnicas.

Specific competences

CEE6. Conocimiento sobre sistemas eléctricos de potencia y sus aplicaciones.

CEE10. Conocimiento aplicado sobre energías renovables.

CRI10. Conocimientos básicos y aplicación de tecnologías medioambientales y sostenibilidad.

CRI11. Conocimientos aplicados de organización de empresas

TEACHING METHODOLOGY

General methodological aspects
The teaching methodology combines theoretical background and practical case studies that will enable the students to obtain a fair understanding of the main ongoing changes and related challenges faced by power systems nowadays. The personal study and a group assignment will complement this classroom training.
In-class activities
▪ **Lectures**: Presentation of the main concepts and real-life experiences by the instructor. They will include dynamic presentations, case studies, and the participation and interaction with students. ▪ **Presentation of assignments:** Oral **p**resentation of the group assignment in front of the rest of students and the course coordinator.
Out-of-class activities
▪ **Personal study** of the material to be discussed in the lectures. This is an individual activity by the students, in which they will read, analyze and question the readings provided as background material, and that will be discussed with other students and lecturers in the classroom.
▪ **Group assignment**: writing a report about one or several of the topics presented in the course expanding the discussion in class. This report is to be presented orally in class in front of the rest of students and the course coordinator.

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
1st intermediate test	▪ Multi-choice test and short questions to evaluate the basic understanding of the concepts in block 1.	12.5%
2nd intermediate test	▪ Multi-choice test and short questions to evaluate the basic understanding of the concepts in block 2.	12.5%
3rd intermediate test	▪ Multi-choice test and short questions to evaluate the basic understanding of the concepts in block 3.	12.5%
4th intermediate test	▪ Multi-choice test and short questions to evaluate the basic understanding of the concepts in block 4.	12.5%
Group assignment and oral presentation	▪ Capability to collect and assess critically information on current challenges faced by real power systems. ▪ Understanding the relevant regulatory concepts and the perspective of the different stakeholders. ▪ Attitude and effort to take the initiative and be proactive. ▪ Written and oral skills in English language.	50%

GRADING AND COURSE RULES

Grading

Regular assessment

Four intermediate tests will be held throughout the course: 1st at the end of module 3, 2nd at the end of module 5, 3rd at the end of module 8, and the 4th one at the end of module 11. An average grade of these four tests will be calculated and it will represent **50% of the final course grade**.

The **group assignment** will be evaluated on the basis of the report submitted and the oral presentation (including the answers to the questions from the audience and course coordinator). This grade will represent **50% of the final course grade.**

In order to pass the course, students must have obtained **minimum grade of 5 out of 10 in each one of the two parts**. Otherwise, the grade will be the lowest of both.

Retakes

The grade for the group assignment will be preserved provided that this is above 50%. Otherwise, students will be required to submit a new report written individually.

In addition, all students who failed in the regular assessment period, will have to take an exam comprising all the contents of the course.

The final grade will be computed as the average of the grades of the group/individual assignment (50%) and the exam (50%). In order to pass the course, the mark of the final exam and the group/individual assignment must be greater or equal to 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

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 Academicas) 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.

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).

WORK PLAN AND SCHEDULE[1]

In and out-of-class activities	Date/Periodicity	Deadline
First intermediate test	Week 4	
Second intermediate test	Week 7	
Third intermediate test	Week 11	
Forth intermediate test	Week 15	
Review and self-study of the concepts covered in the lectures	After each lesson	
Data collection and reporting for group assignment	During the last half of the course	Week 15
Preparation of oral presentation	Weeks 14 and 15	Week 15
Oral presentation of group assignments	Week 15	

[1] A detailed work plan of the subject can be found in the course summary sheet (see last page). Nevertheless, this schedule is tentative and may vary to accommodate the rhythm of the class.

STUDENT WORK-TIME SUMMARY		
IN-CLASS HOURS		
Lectures	**Oral presentations**	
56	4	
OUT-OF-CLASS HOURS		
Self-study	**Data collection and reporting for group assignment**	**Preparation of oral presentation**
40	60	20
	ECTS credits:	**6 (180 hours)**

BIBLIOGRAPHY

Basic bibliography

- Case studies and references presented in each of the modules
- "Electric Energy Challenges of the future", EPRI, 2012

Complementary bibliography

- "Regulation of the Power Sector", Edited by Ignacio Pérez Arriaga, Springer-Verlag, 2013.
- "Las redes eléctricas inteligentes", Fundación Gas Natural Fenosa (in Spanish)
- "The Future of the Electric Grid". An Interdisciplinary MIT study, 2011.

	IN-CLASS ACTIVITIES			OUT-OF-CLASS ACTIVITIES		
Week	h/w	LECTURE & PROBLEM SOLVING	ASSESMENT	h/w	SELF-STUDY	ASSESSMENT PREPARATION AND REPORTING
1	4	Introduction Coordinated transmission expansion planning		4	Review and self-study	
2	4	Coordinated transmission expansion planning		5	Review and self-study	
3	4	Integrating HVDC Transmission Supergrids into Existing System		5	Review and self-study	
4	4	Electricity Market Design Under Large Shares of Intermittent Generation	1st intermediate test	7	Review and self-study	
5	4	Electricity Market Design Under Large Shares of Intermittent Generation Design of Capacity Mechanisms under Different Contexts		5	Review and self-study	
6	4	Design of Capacity Mechanisms under Different Contexts		5	Review and self-study	
7	4	Smart Distribution Systems	2nd intermediate test	7	Review and self-study	
8	4	Smart Distribution Systems Communication Systems Applied to Electricity Networks		8	Review and self-study	Data collection and reporting for group assignment
9	4	Communication Systems Applied to Electricity Networks		8	Review and self-study	Data collection and reporting for group assignment
10	4	Energy Management in Smart Cities and Smart Homes		8	Review and self-study	Data collection and reporting for group assignment
11	4	Energy Management in Smart Cities and Smart Homes Rural Electrification and Universal Access	3rd intermediate test	10	Review and self-study	Data collection and reporting for group assignment
12	4	Rural Electrification and Universal Access		8	Review and self-study	Data collection and reporting for group assignment
13	4	Operation of Small Isolated Power Systems		8	Review and self-study	Data collection and reporting for group assignment
14	4	Enhancing Energy Efficiency in Railway Systems		12	Review and self-study	Data collection and reporting for group assignment Preparation of oral presentation
15	4	Presentation of assignments	4th intermediate test	20	Review and self-study	Data collection and reporting for group assignment Preparation of oral presentation