COURSE SYLLABUS 2020-21

GENERAL INFORMATION

Course information	
Name	Regulation and New Business Models
Code	E000008148
Degree	Master in Smart Grids Máster Universitario en Ingeniería de Telecomunicación + Máster in Smart Grids Máster Universitario en Ingeniería Industrial + Máster in Smart Grids
Year	2020-21
Semester	1
ECTS Credits	7.5
Type	Compulsory
Department	Electrical Engineering Department
Area	Electric power systems regulation
Coordinators	Carlos Batlle and Pablo Rodilla

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DETAILED INFORMATION

Course context

Contribution to the professional profile of the degree

The course presents an in-depth interdisciplinary perspective of the electric power sector, with regulation providing the link among the engineering, economic, legal and environmental viewpoints.

Electricity markets, incentive regulation of networks, reliability of service, renewable energy sources, contemporary network issues, retail competition, tariff design, distributed generation, multinational electricity markets, environmental impacts, future of utilities and strategic sustainability issues will be addressed under both traditional and competitive regulatory frameworks.

The course will make available the economic and legal basis to critically evaluate the regulatory instruments that are used worldwide for electricity supply activities that are performed as regulated monopolies or under competitive conditions. Most of these regulatory approaches are also of application in other industrial sectors.

The knowledge acquired in the course will provide the comprehensive understanding of electric power systems that will be needed for research in this field, as well as for future professional activities in the energy sector, whether in industry, government or consulting.

The key objective is to provide the student with a solid grasp of the fundamentals of energy regulation. The main learning outcomes are:

- Fundamentals of energy system economics, introduction to different regulatory models and the restructuring process of the power sector
- Approaches to the regulation of transmission and distribution networks as natural monopolies and principles for the allocation of regulated costs
- Market design of competitive electricity wholesale markets and its complements, being ancillary services and possibly capacity mechanisms
- Regulatory and technological challenges for the widespread inception of retail markets

Pre-requirements

CONTENTS

Competences and learning outcomes

Competences

Basic Competences

CB3. Know how to evaluate and select the appropriate scientific theory and precise methodology of their field of study to make judgments based on incomplete or limited information including, where necessary and appropriate, a critical review on the social and ethical responsibilities linked to the solution proposed in each case

Specific Competences

CE5. Understand the regulatory role and instruments available to regulate monopolies and to promote competition.

CE6. Knowing the market economic principles and different approaches to the regulation of monopolies and oligopolies and the differential aspects of the electricity sector.

Learning outcomes

At the end of the course, the students will have to be able to:

RA1. Assess and to select the most appropriate approach for regulating the electric power business, considering its social and economic implications.

RA2. Understand the regulatory function and the economic principles underlying the different regulatory schemes and the instruments to regulate monopolistic and competitive activities.

RA3. Understand the differential aspects of the electric power industry.

RA4. Know the most appropriate regulatory scheme for each one of the electric power activities, considering the particularities of each system.

RA5. Be able to properly discuss and analyze regulatory design in the context of real-life case examples.

TEACHING METHODOLOGY

The teaching method is focused on easing the learning of knowledge and increasing the student critical thinking on electric power regulation theory.

General methodological aspects	
	Competences
▪ **Lectures**: Description of the course contents and open discussion of concepts. The students have also to try to respond to the numerous questions posed by the instructors throughout the lecture.	C1 to C8
▪ **Term paper discussion:** The papers will be discussed with the instructors with no presentations (as the instructors have read already the papers, the session will consist of just discussion on the content of the term papers, which, admittedly, cover many topics so the discussion could be broad	C1 to C8
▪ **Tutorial activities. Available according to the need of the student**	C1 to C8
Out-of-class activities	**Competences**
▪ Teaching resources require the active participation of the student. In addition, the classroom activity should be complemented by the individual student work performed out of class. Both aspects are taken into account in the evaluation method.	C1 to C8
▪ **Term task**. Regulatory analysis of a power system chosen among a list of suggestions developed by the instructor. The student has to face her own research, in order to develop the ability to first investigate the current state of the regulation of a real case, and also to apply the critical skills acquired to build regulatory recommendations (40 hours).	C1 to C8
▪ **Personal work of the student**. Study of the course contents.	C1 to C8

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
Mid-term exam (after half of the material has been covered).	Exams are a combination of short questions and a multi-option test. ▪ Understanding of the theoretical concepts ▪ Application of concepts to the solution of practical problems	30%
Final term (rest of the contents, although it might include questions about the material included previous exam)	▪ Understanding of the theoretical concepts ▪ Application of concepts to the solution of practical problems	35%
Participation in the class	▪ Contribution to the class discussions	5%
Term paper	▪ The term paper will be evaluated from two points of view: ▪ The quality of the document itself, the clarity and comprehensiveness of the description of the regulation implemented in the power system assigned. The soundness of the references used are also pondered. ▪ The oral presentation of the work, the way the students build up their discussions, and their ability to back their proposals and to respond to the questions received.	30%

GRADING AND COURSE RULES

Grading

Regular assessment

- **Theory** will account for 65%, of which:
  - Mid-term exam: 30%
  - Final exam: 35%
- **Participation in class** will account for 5%
- **Term paper** will account for the remaining 30%

In order to pass the course, the mark of the final exam must be greater or equal to 4 out of 10 points and the laboratory mark must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

Retake

The student has two periods of final evaluation during one academic year. The first one will be carried out at the end of course (end of the semester). In case that this was not passed obtaining 5 or more points, the student has another opportunity of final evaluation at the end of the academic year. The dates of evaluation periods will be announced in the web page.

The new grade will by obtained as follows:

- 65% New exam covering the whole course.
- 5% Participation in class
- 30% Term task (the student can resubmit to improve the first grade received).

The mark of the retake final exam must be greater or equal to 4.5 out of 10 points and the mark of the final project must be at least 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 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).

WORK PLAN AND SCHEDULE

Session		In-class activities
#	hours	
1	2	WHAT'S REGULATION ABOUT?
2	2	THE REGULATORY FUNCTION
3	2	REGULATORY MODELS • Energy services pricing: from regulated costs to price competition: Cost-of-service regulation. Incentive regulation. Competitive bidding. Market competition • Energy systems' governance: activities, structure, and stakeholders' roles: Unbundling. System and market operation
4	2	
5	2	
6	2	FUNDAMENTALS OF ENERGY SYSTEMS ECONOMICS • Centralized versus market-based planning: Costs' characterization: investment, average and marginal costs. Cost minimization versus profit maximization • Basics on energy contracts: Physical versus financial contracts
7	2	
8	2	COST ALLOCATION METHODOLOGIES • Basic pricing principles. Locational marginal pricing. Monopoly pricing
9	2	
10	2	PRICING ELECTRICITY GENERATION • Investment and operation planning: From central planning and operation to wholesale markets • Energy markets design elements: Market-based economic scheduling: Market models, bidding formats and clearing algorithms
12	2	
13	2	
14	2	COMPLEMENTS TO ENERGY MARKETS • Flexibility markets: Intraday, reserves and regulation markets. • Capacity and RES-support mechanisms: Design elements of capacity and RES promotion mechanisms
15	2	
16	2	
17	2	
18	2	EXAM 1
19	2	INTERPLAY BETWEEN TRANSMISSION AND GENERATION • Exercise: single vs. nodal pricing. Congestion rents. Financial Transmission Rights • Characterization of transmission. Regulatory treatment of transmission investment planning (golden rules), business models
20	2	
21	2	

22	2	REGULATED REVENUES AND COST ALLOCATION • Remuneration mechanisms for distribution: Cost-of-service, RPI-X, TOTEX… • Network costs allocation: Transmission and distribution tariffs
23	2	
24	2	
25	2	
26	2	END-USER TARIFFS • Principles and basic tariff structures: Efficiency & equity. Additivity, components. • Time and locational granularity: Dynamic, TOU, fixed, …
27	2	
28	2	
29	2	RETAIL MARKETS • Business models: Retail activities, stakeholders' roles. • Consumer protection: Data management, switching, vulnerable customers
30	2	
31	2	
32	2	CONTEMPORARY ELECTRIC POWER SYSTEMS' ISSUES • Future Challenges and Trends of Electric Power Systems • Regulation of New Energy Resources and Solutions
33	2	
34	2	
35	2	
36	2	EXAM 2
37	2	TERM PAPERS' DISCUSSION
38	2	

SUMMARY OF WORKING HOURS OF THE STUDENT			
CLASSROOM HOURS			
Lectures and class discussions	**Term paper**	**Tutoring**	
65	10	Up to 10	
NON-CLASSROOM HOURS			
Personal work of the student	**Out-of-class assignments**		
80	40		
		ECTS CRÉDITS:	**7.5**

BIBLIOGRAPHY AND RESOURCES

Bibliography

Readings

"Regulation of the electric power sector". Pérez-Arriaga Ed., Springer Verlag, 2013

- Body of Knowledge on Infrastructure Regulation
  - http://regulationbodyofknowledge.org/
- Schweppe, F.C., Caramanis, M.C., Tabors, R.D., Bohn, R.E., 1988. Spot pricing of electricity. Kluwer Academic Publishers.
- Kahn, A.E., 1988. The economics of regulation: Principles and institutions. The MIT Press.
- Stoft, S., 2002. Power System Economics, Wiley-IEEE Press.
- Joskow, P. L., 2003. "The difficult transition to competitive electricity markets in the U.S." May 2003. Available at http://dspace.mit.edu/handle/1721.1/45001.
- Al-Sunaidy, A., R. Green, 2006. "Electricity deregulation in OECD (Organization for Economic Cooperation and Development) countries. Energy, vol. 31, pp. 769–787.
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  - Rodilla, P. & Batlle, C. 2010. "Security of electricity supply at the generation level: problem analysis". Working Paper IIT-10-027A, Energy Policy, vol. 40, pp. 167.185.
  - Batlle, C., Pérez-Arriaga, I. J., Zambrano-Barragán, P., 2011. "Regulatory design for RES-E support mechanisms: Learning curves, market structure, and burden-sharing". MIT CEEPR 2011-011 Working Paper, May 2011. Energy Policy, vol. 41, pp. 212-220.