Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2025/26

Faculty 345 - Faculty of Engineering - Bilbao **Cycle** .

Degree INTER401 - Máster in Integration of Renewable Energy Sources Into The Elec **Year** .

COURSE

502149 - Electric Energy Converters Applied to Distributed Generation **Credits, ECTS:** 3

COURSE DESCRIPTION

The subject "Electric Power Converters Applied to the Distributed Generation" is intended to complete the global vision of electricity generation systems from renewable sources, taught together with the subjects "Wind Generation" and "Design of electrical machines regulation". Focusing on the knowledge of the electricity generation converters used today for renewable energy generation, as well as those that are in the process of development for this purpose.

The dynamic models of the electric power converters will be analyzed in depth, from the synchronous generators with continuous excitation and permanent magnets (PMSG), through the squirrel cage and doubly fed asynchronous (DFIG) and the power electronic converters. The objective is to study its influence on the stability of the power system and provide the basis for the study of control algorithms, carried out in other subjects of the master.

The individual objectives are:
- To provide students with a rigorous knowledge of the electric power converters, necessary for the design and implementation of vector control schemes.
- To train students for the implementation of simulation models of the predominant electric machines in the generation of renewable energy
- Provide students with the necessary tools to analyze the stability of power systems with different types of electric power converters
- To introduce students in the process of design, adjustment and digital implementation of vector control schemes of the different converters

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Students are able to acquire and relate properly the theoretical and practical concepts related to electrical energy converters applied to distributed energy generation.
Students are able to analyze and solve problems in new scenarios, different from those proposed during their training, and that require coordination with other disciplines, in order to optimize the implementation and exploitation of electrical energy converters applied to distributed energy generation.
Students are able to integrate the acquired knowledge in order to develop, coordinate and control technical activities related with electrical energy converters applied to distributed energy generation.
Students are able to apply the required technical knowledge considering the technological, legal, social and environmental aspects of the related activities.
Students are able to transmit clearly their acquired knowledge, and the scientific and technological fundamentals in which those are founded. Students are able to adapt their speech related to the field of electrical energy converters applied to distributed energy generation to the target public (specialist or non-specialist).
Students are able to autonomously update their training, enhancing the acquired knowledge, and performing successfully research related activities, in the field of electrical energy converters applied to distributed energy generation.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

To select the proper model of the electric generator for offshore renewable energy production depending on the technology and type of study.
To model different electric generators for dynamic studies including it associated controllers.
To implement dynamic models of electric generators in a power system simulator software of general use.

Theoretical and Practical Contents

TOPIC 1: Introduction.
- Dynamic modelling of electri power converters.
- Per unit system.
- Space Vector Transformations

TOPIC 2: Syncrhonous generator.
- Principle of operations
- Dynamic model
- Symplified dynamic model. Classical model
- Steady state model
- Mechanical model

TOPIC 3: Asynchronous generator.
- Principle of operation
- Dynamic model
- Symplified dynamic model
- Steady state model
- Mechnical model

TOPIC 4: Power converters (VSC)
- Principle of operation
- Dynamic model
- Steady state model

TOPIC 5: Doubly Fed Induction Generator
- Principle of operation
- Dynamic model
- Steady state model
- Operation of DFIG
- Control of DFIG
- Mechanical model

TEMA 6: Control of electric power converter
- Control of power electronic converters
- Control os synchronous generators
- Control of DFIG

METODOLOGIA (ACTIVIDADES FORMATIVAS)

Actividad Formativa	Hours	Porcentaje presencialidad
Practices and seminars	2	100 %
Tutorials	5	100 %
Classroom/Seminar/Workshop	8	100 %
Expositive classes	15	100 %
Systematised study	21	0 %
Individual work and/or group work	24	0 %

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	15	2	8	2					3
Horas de Actividad No Presencial del Alumno/a	25	3	10	4					3

Legend:
M: Lecture-based — S: Seminar — GA: Applied classroom-based groups
GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation tools and percentages of final mark

Denominación	Ponderación mínima	Ponderación máxima
Attendance and participation	0 %	10 %
Computer practicals	0 %	40 %
Realización de prácticas (ejercicios, casos o problemas)	0 %	50 %

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

CONTINUOUS ASSESMENT:

The subject is evaluated according to three methods:

1. Attendance and active participation in class: 0 - 10%
2. Exercises: 0 - 50%
3. Computer practicals: 0 - 40%

To pass the subject, a minimum global mark of 5 (pass) is needed, when the minimum mark in methods 2 and 3 is above 3.5 points. If this minimum is not achieved the final mark will be 4.5 (fail)

To renounce the continuous assesment methodology, the student must request in writing to the academic committee of the master, within a period not less than a week from the official date of the final exam established for the subject.

FINAL EVALUATION

In the event that the continuous assessment is waived, the final evaluation system will consist of an evaluation test of each block, whose weighting will be as follows:

- Theory: 50%. Indludes all the subjects studied in the lecturesç+
- Practice: 50%. Includes an exercise similar to those solved in class or assignments

To pass the subject, a minimum mark of 5 (pass) is needed in each block. If this is not achieved, the final mark will be 4.5 (fail)

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

FINAL EVALUATION

In the event that the continuous assessment is waived, the final evaluation system will consist of an evaluation test of each block, whose weighting will be as follows:

- Theory: 50%. Indludes all the subjects studied in the lecturesç+
- Practice: 50%. Includes an exercise similar to those solved for homework

To pass the subject, a minimum mark of 5 (pass) is needed in each block. If this is not achieved, the final mark will be 4.5 (fail)

MANDATORY MATERIALS

All the materials for the course are available in eGela

BIBLIOGRAPHY

Basic bibliography

[1] CHAPMAN , S J. Electrical Machinery Fundamentals. 5ª edition. McGraw-Hill Companies. New York 2012.
[2] FRAILE, J. Máquinas Eléctricas. 6ª edición. McGraw-Hill Interamericana de España. Madrid 2008.
[3] FITGERALD, A. E., KINGSLEY CH., UMAS, S. D. Electrical Machinery, 6ª edition. McGraw-Hill (2005)
[4] B.W. WILLIAMS. Principles and Elements of Power Electronics. Barry W. Williams, 2006.
[5] SANZ FEITO, J. (2004). Máquinas Eléctricas. Pearson Prentice-Hall. Madrid 2002.

Detailed bibliography

[1] MAZÓN, J, y otros, Guía de Autoaprendizaje de Máquinas Eléctricas, Pearson Prentice Hall, Madrid 2008
[2] LAITHWAITE, E.R.; Máquinas de Inducción Especiales. Editorial Labor S.A.
[3] PÉREZ DONSIÓN, M. FERNÁNDEZ FERRO, M.A. Motores Síncronos de Imanes Permanentes. Universidade de Santiago de Compostela- Servicio de Publicaciones e Intercambio Científico.
[4] RASHID , M. H. Electrónica de Potencia: Circuitos, Dispositivos y Aplicaciones. Ed. Prentice-Hall Hispanoamericana S. A.
[5] CATHEY, J .J. Máquinas Eléctricas. Análisis y Diseño Aplicando MATLAB. McGraw-Hill. 2002.
[6] CHEE-MUN ONG. Dynamic Simulation Of Electric Machinery Using MATLAB/SIMULINK. Prentice Hall PTR. 1998.
[7] LOI LEI LAI, Distributed Generation, Induction and Permanent Magnet Generators, J. Wiley & Sons, Ltd. 2007.

Journals

Web sites of interest

[1] REE (Red Eléctrica de España) Informe del sector eléctrico 2010 y sucesivos, http://www.ree.es
[2] IDAE (Instituto para la Diversificación y Ahorro de la Energía). Planes y Manuales de Energías Renovables. http://www.idae.es
[3] www.alstom.com/
[4] www.abb.com/
[5] www.gamesacorp.com/
[6] www.bornay.com/
[7] www.enpresa.ehu.es/223-contet/es.../es.../Apert_Renovables2.pdf
[8] www.iit.upcomillas.es/pfc/resumenes/433aele72c560.pdf
[9] www.Galiciaparkeolico.net/links2.php
[10] www.ingeteam.com