Universidad de Alcalá

TEACHING GUIDE

ELECTRONIC SYSTEMS FOR DISTRIBUTED ENERGY MANAGEMENT AND MICROGRIDS

Master's Degree in Electronic Engineering

University of Alcalá

Academic Year 2023/2024
Second Semester

TEACHING GUIDE

Subject Name:	**Electronic systems for distributed energy management and electrical microgrids**
Code:	**202940**
Degree	**Master's Degree in Electronic Engineering**
Department and Area of Knowledge:	**Department: Electronics** **Area: Electronics Technology**
Character:	**Optional**
ECTS credits:	**4,5**
Course and term:	**2nd semerter**
Faculty:	**Consult the web page of the Electronics Dept.**
Tutoring Schedule:	**Consult the web page of the Electronics Dept.**
Modality:	**Blended learning**
Language in which it is taught:	**Spanish-English Friendly**

1. COURSE SUMMARY

This elective subject is located in the speciality "Electronic Power Systems and Energy Management".

It studies power and control electronic systems for distributed generation systems, such as photovoltaic systems, wind power systems, etc. It is completed with the study of micro-grids and their management, energy storage systems and Virtual Power Plants.

The course is aimed at providing theoretical and practical training on electronic systems and their control within the most relevant current applications of micro-grids and distributed generation.

2. COMPETENCIES and LEARNING OUTCOMES

This subject contributes to the acquisition of the following basic, general and specific competences:

Basic competences

CB6	Possess and understand knowledge that provides a basis or opportunity for originality in the development and/or application of ideas, often in a research context.
CB7	Students are able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB8	Students must be able to integrate knowledge and face the complexity of formulating judgements based on incomplete or limited information, including reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.
CB9	Students are able to communicate their conclusions - and the ultimate knowledge and reasons behind them - to specialist and non-specialist audiences in a clear and unambiguous way.
CB10	Students possess the learning skills that will enable them to continue studying in a largely self-directed or autonomous manner.

General competences	
CG1	Produce concise, clear and reasoned documentation, specifying the work to be carried out for the development, integration and implementation of complex, high added-value electronic systems.
CG2	Conceive, design, implement and maintain an electronic system in a specific application.
CG3	Acquire skills for the understanding of new technologies for use in electronic systems and their appropriate use and integration for the resolution of new problems or applications.
CG4	Acquire teamwork skills integrating multidisciplinary approaches.
CG5	Acquire public communication skills of concepts, developments and results related to activities in Electronic Engineering, adapted to the profile of the audience.
CG6	To adopt the scientific method as a fundamental working tool to be applied both in the professional and research fields.

Specific competences	
CE1	Ability to design electronic systems both at conceptual level, starting from specific specifications, and at system level, using modelling and simulation tools, as well as at subsystem level using hardware description languages, among others.
CE2	Knowing the capabilities of new analogue, photonic and power electronic components to improve the performance of current systems or applications.

CE3	Ability to handle advanced tools, techniques and methodologies for the design of electronic and photonic systems or subsystems.
CE4	Ability to design a device, system or application that meets given specifications, using a systemic and multidisciplinary approach and integrating the advanced modules and tools that are specific to the field of Electronic Engineering.
CE5	Ability to design, implement and manage a set of tests and experimental measurements to evaluate the operation of an electronic, microelectronic and photonic system.
CE6	Ability to participate in a multidisciplinary technical work team in the field of Electronic Engineering, with the ability to react to technical and operational difficulties within the framework of the development of a technological project.
CE7	Ability to experimentally verify in the laboratory the compliance with the specifications required of a new electronic and photonic system after its design.
CE8	Ability to solve practical problems arising from the interaction of elements within an electronic system and with external agents, with effects such as signal interference, electromagnetic compatibility or thermal management, in the phases of design, prefabrication and in redesign situations.
CE9	Ability to identify merit factors and effective comparison techniques to obtain the best solutions to scientific and technological challenges in the field of Electronic Engineering and its applications.
CE10	Ability to apply optimisation techniques to the development of electronic circuits and subsystems.
CE11	Ability to carry out effective information searches and to identify the state of the art of a technological problem in the field of electronic and photonic systems, as well as its possible application to the development of new systems.
CE12	Knowledge of the current state of the art and future trends in some of the following areas: power electronics, control electronics, microelectronics and photonics.
CE13	Ability to identify, from a conceptual but also practical point of view, the main scientific and technological challenges in different applications of electronic systems, as well as in their integration and use.
CE14	Plan the development of an electronic product, from the design phase to its preparation for commercialisation, complying with the current regulations applicable to electronic systems in terms of electrical safety, electromagnetic compatibility and the environment.

On the other hand, the expected learning outcomes of this subject are the following:

RAP1. Strengthen advanced, theoretical and practical aspects of power electronics applied to renewable generation systems.

RAP2. Deepen the knowledge of power electronic systems and their control used in microgrids.

RAP3. Analyse all aspects related to the management of microgrids and VPPs (virtual power plants).

3. CONTENTS

The subject includes the following contents:

Brief description of its contents

Content blocks (topics can be specified if necessary)	Total hours
Block 1. Electronics for distributed generation	• **21 hours**
Topic 1: Photovoltaic solar energy (9 h)	
Topic 2: Wind energy (9 h)	
Topic 3: Other sources (3h)	
Block 2. Micro-grids.	• **21 hours**
Topic 4: Concept of microgrid. (3h)	
Topic 5: Storage in microgrids (6h)	
Topic 7: Control, management and protection for microgrids (9h)	
Topic 8: Power quality and reliability in microgrids. Legislation (3h).	
Block 3. Virtual Power Plant	• **3 hours**
Topic 9: Introduction to virtual power plants (3h)	
TOTAL	**45 hours**

4. TEACHING-LEARNING METHODOLOGIES - TRAINING ACTIVITIES

4.1. Distribution of credits (specify in hours)

Number of hours of theory and practical classes:	32,5 h: 9h in person or online synchronous and 23,5h online.
Number of hours of the student's own work	55 h
Other: tutorials, tests, virtual classroom activity.	25h
Total	112,5 h

4.2. Methodological strategies, teaching materials and resources

The following training activities will be carried out in the teaching-learning process:

Theoretical classes and problem solving	17,5 h
Theoretical-practical classes and laboratory practicals.	15 h
Tutorials	12,5 h
Other: student work, virtual classroom activity and tests.	67,5 h

Throughout the course, students will be proposed activities and tasks so that they can experiment and consolidate the concepts acquired.
In order to carry out the practical exercises, the student will have a computer and the necessary elements for experimenting with design techniques for electronic control systems for distributed generation and microgrids.
Throughout the learning process of the subject, the student will have to make use of different bibliographic or electronic sources and resources, so that he/she becomes familiar with the documentation environments that he/she will use in the research or professional field.

5. EVALUATION: Procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment system with formative assessment characteristics, so that it serves as feedback in the teaching-learning process on the part of the student. To this end, the following are established:

5.1 Evaluation Procedures

The proposed assessment process is based on continuous assessment, although, in accordance with the regulations of the University of Alcalá, students may opt for final assessment.

5.2. Evaluation Criteria

The Assessment Criteria must address the degree of acquisition of competences by the student. To this end, the following are defined.

- CE1: The student will be able to correctly solve problems related to the design of electronic systems for renewable energy management.
- SC2: The student integrates the knowledge explained in the different theory subjects in order to be able to solve the problems posed in a creative and original way.
- SC3: The student implements in practice electronic systems for the control of distributed generation and microgrids that provide solutions to the problems posed, integrating the knowledge acquired, making use of the bibliographic resources and computer tools available to them.
- SC4: The student is capable of generating correctly written, clear and precise documentation on the work carried out in the laboratory.
- SC5: The student presents and defends his/her proposals for solving the problems posed in a clear and reasoned manner.

5.3. Assessment instruments

Assessment instruments to be applied:

1. Basic knowledge test consisting of a series of multiple-choice questions addressing the basic theoretical aspects of the subjects taught.

2. Questions relating to the design of renewable generation systems in the form of practical problems.
3. Laboratory practicals. This consists of the design, simulation and implementation of practical applications of renewable generation systems and microgrids. A report of the work carried out will be presented and defended individually.

The acquired competences assessment system includes the following components:

- Evaluation of the theoretical part (PT) 50%.
- Open-response written test (questions) 30%.
- Objective test (multiple-choice test) 20%.
- Evaluation of the practical part in the laboratory (PP) 50%.

The overall grade for the course will be the weighted mark with the percentages indicated, provided that at least 40% of the maximum mark has been achieved in each set of tests assessed (theory and practical).

5.4. Qualification criteria

5.4.1. Continuous Assessment Model:

a) **Ordinary Examination**. Students will be continuously assessed by means of tests distributed throughout the teaching period. The percentages of weight of such tests in the final grade as well as the relationship between the criteria and instruments of evaluation of the subject is as follows:

Learning outcomes	Evaluation Criteria	Qualification instrument	Weight in rating
RAP1, RAP2, RAP3	CE1, CE2, CE5	PT	50%
	CE3, CE4, CE5	PP	50%

A student will be considered to have participated in the teaching-learning process and, therefore, to have taken the ordinary exams if he/she takes any of the tests scheduled for the theoretical part (PT) or the practical part (PP).

Students will be considered to have passed the subject if they achieve an overall weighted grade equal to or higher than 5 (out of 10) among all the grading instruments, having obtained a minimum grade in each of the parts (PT and PL) of at least 40% of the maximum grade.

b) **Extraordinary convocation.** Students who do not pass the ordinary exam will be entitled to an extraordinary exam. The theoretical part will be assessed by means of an exercise with tests and questions, and the practical part by means of a practical laboratory exam. The percentages of weight of these tests in the final grade as well as the relationship between the criteria, evaluation instruments and the learning outcomes of the subject are as follows:

Learning outcomes	Evaluation Criteria	Qualification instrument	Weight in rating
RAP1, RAP2, RAP3	CE1, CE2, CE5	PT	50%
	CE3, CE4, CE5	PP	50%

Students will be considered to have passed the subject if they achieve an overall weighted mark equal to or higher than 5 (out of 10) among all the marking instruments, having obtained a minimum mark in each of the parts (PT and PL) of at least 40% of the maximum mark.

5.4.2. Final Evaluation Model:

Ordinary and Extraordinary Convocation.

Those students who opt for the final assessment model, both in the ordinary and extraordinary call, must pass: the theoretical part by means of an exercise with tests and questions, and the practical part by means of a practical laboratory exam. The percentages of weight of these tests in the final grade as well as the relationship between the criteria, assessment instruments and learning outcomes of the subject is as follows:

Learning outcomes	Evaluation Criteria	Qualification instrument	Weight in rating
RAP1, RAP2, RAP3	CE1, CE2, CE5	PT	50%
	CE3, CE4, CE5	PP	50%

Students will be considered to have passed the subject if they achieve an overall weighted mark equal to or higher than 5 (out of 10) among all the marking instruments, having obtained a minimum mark in each of the parts (PT and PL) of at least 40% of the maximum mark.

6. BIBLIOGRAPHY

6.1 Basic Bibliography

- Documentation produced by the teachers of the course.

- Microgrids and active distribution networks. IET 2009
- Power electronics for renewable and distributed energy systems. Sudipta Chakraborty et al. Springer. 2013

6.2 Complementary Bibliography

- Energy Harvesting. Solar, wind and Ocenan Energy Conversion Systems. Alira Khaligh. CRC Press. 2010.
- Wind and solar power systems. Mukund R. Patel. Taylor and Francis. 2006