Universidad de Alcalá

TEACHING GUIDE

Power Electronics

Degree in
Telecommunication Technologies Engineering (GITT)
Electronic Communications Engineering (GIEC)

Universidad de Alcalá

Academic Year 2025/2026

4th Year - 2nd Semester (GITT)

3rd Year - 1st Semester (GIEC)

Approved by the EPS School Board on June 16th, 2025

TEACHING GUIDE

Course Name:	**Power Electronics**
Code:	**350044 (GITT)** **370000 (GIEC)**
Degree in:	**Telecommunication Technologies Engineering (GITT)** **Electronic Communications Engineering (GIEC)**
Department and area:	**Electrónica** **Electronic Technology**
Type:	**Optional (Specialized) (GITT)** **Compulsory (GIEC)**
ECTS Credits:	**6.0**
Year and semester:	**4th Year - 2nd Semester (GITT)** **3rd Year - 1st Semester (GIEC)**
Teachers:	See webpage: https://www.depeca.uah.es or Blackboard Learn System
Tutoring schedule:	Check in Blackboard at the beginning of the course
Language:	Spanish/English friendly

1. COURSE SUMMARY

This course is intended for students in the third year of the Degree of Electronic Engineering of Communications, being imparted in the first semester. This subject is also offered as an elective in the Degree of Telecommunication Technologies. It involves the initiation of students in the discipline of power electronics basing on electricity and electronics previously studied subjects.

The contents of the course include the study of specific power devices and basic aspects of power electronic converters (DC / AC, DC / DC, AC / DC), including its most common topologies, operating modes, limitations, potential applications, etc.

The course follows a theoretical and practical approach, based on the systematic development of exercises and practical cases, as well as simulation and implementation of some of the power systems in the laboratory. The specific skills acquired in this course will be useful for both continuing with further studies in the field, and, also, for the professional development in such diverse fields as industrial automation, power systems, renewable energy generation and distribution electricity, etc.

Prerequisites and Recommendations

- Electrical and electronic circuits analysis.
- Common digital and analog electronic devices knowledge.
- Mathematics for engineering (Fourier and Laplace transform, linear algebra, differential equations)
- Matlab/Simulink.

Students must come to exams with a document of identity (student card, ID card or passport).

Virtual Classroom (**Blackboard platform**) is used as tool for student-teacher communication and as repository for the different teaching materials and tasks. Each student has to upload a recent photograph in this platform at the beginning of the semester and to maintain a valid email address.

It is recommended that the student follows a continuous study of the subject. It is also very important to respect the job submission dates.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/352/2009:

en_TR2 - Knowledge of basic subjects and technologies that enables to learn new methods and technologies, as well as to provide versatility that allows adaptation to new situations.

en_TR3 - Aptitude to solve problems with initiative, decision making, creativity, and to communicate and to transmit knowledge, skills and workmanship, comprising the ethical and professional responsibility of the activity of the Technical Engineer of Telecommunication.

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the Orden CIN/352/2009:

en_CSE1 - Ability to build, operate and manage capture, transportation, representation, processing, storage, management and presentation of multimedia information systems, from the point of view of the electronic systems.

en_CSE4 - Ability to apply electronics as a support technology in other fields and activities, and not only in the field of Information and Communications Tecnology.

en_CSE5 - Ability to design analog and digital electronic circuits, analog-digital and digital-analogue conversion, radio frequency, power and conversion of electric power for applications of telecommunication and computing.

en_CSE9 - Ability to analyze and solve interference and electromagnetic compatibility problems

Learning results:

RA1: Explain the general concepts of power electronics.

RA2: Describe and explain the operation of electronic switching devices and their typical applications.

RA3: Illustrate, interpret and use basic power converters and their most common variations.

RA4: To apply the knowledge of power electronics to the resolution of technical problems.

RA5: Use electronic circuit analysis tools and programs to support the design, modeling and simulation of power electronic circuits.

3. CONTENTS

- Chapter 0: Introduction (1h in Big Group-BG)
  - Lesson 0: Introduction to the subject.
- Chapter 1: Introduction to Power Electronics. (5h BG, 4h Small Group-SG)
  - Lesson 1: Introduction to Power Electronics.
  - Lesson 2: Electrical Circuit Review.
- Chapter 2: Electronic Devices for Power Electronics. (4h BG, 4h SG)
  - Lesson 3: Power Electronic Devices.
- Chapter 3: Switched DC/DC converters.(10h BG, 10h SG)
  - Lesson 4: Introduction to DC/DC conversion. Step-down converter.
  - Lesson 5: Step-up and Step-down-step-up converters.
  - Lesson 6: Full-bridge converter.
  - Lesson 7: Isolated DC/DC converters: Flyback converter, Forward converter.
- Chapter 4: Uncontrolled and Controlled AC/DC converters.(5h BG, 5h SG)
  - Lesson 8a: Single-phase diode rectifiers.
  - Lesson 8b: Three-phase diode rectifiers.
  - Lesson 9: Other rectifiers: Introduction to thyristor rectifiers.
- Chapter 6: DC/AC converters.(4h BG, 4h SG)
  - Lesson 10: Single-phase DC/AC converters.
  - Lesson 11: Three-phase DC/AC converters.

Time distribution

See Annex (at the beginning of the course).

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Hours in a classroom setting:	58 hours (56 in-person classes + 2 final evaluation): 29 theoretical and 27 practical. On the practical side, approximately 80% is lab work and 20% is problem solving.
Time of student work on their own:	92
Total:	150

4.2. Methodological strategies, teaching materials and resources

In the teaching-learning process the following training activities will be held:

- *Lectures* (theory classes).
- *Practical problem classes*.
- *Lab classes*.
- *Tutorship sessions:* individual or group sessions.

The following additional resources may also be used:

- Individual or group works, which could be exposed, in addition to its realization, to the rest of the class to stimulate discussion.
- Attendance at conferences, meetings or discussions related scientific field.

Throughout the course the student will be offered both theoretical and practical activities and tasks. Different practices will be carried out in coordination with the teaching of theoretical concepts; in this way the student can experience and consolidate the concepts acquired, both individually and in groups.

In order to carry out the practices, the student will have a stand in the laboratory with basic instruments (oscilloscope, power supply, signal generator), as well as a computer with design software and electronic circuit simulation program (Matlab/Simulink). In this subject, it is proposed that the practices be carried out in groups of two students, although it can also be individual.

Throughout the learning process in the course, students will use different bibliographic and electronic resources, in order to become familiar with the environments of documentation they will use professionally in the future. In addition, teachers will provide own materials developed specifically for the course (theoretical papers, collections of exercises and problems, practice manuals, audiovisuals, etc.) so that students can meet the course objectives and achieve the competences described.

Students will be provided throughout the semester with tutorship in group (if requested by the students themselves) or individual. Whether individually or in small groups, this tutorship will resolve doubts and consolidate the knowledge acquired. Also it will help to make appropriate monitoring and assess the proper functioning of the mechanisms of teaching and learning.

Finally, the whole development of the subject will be detailed on the website (Blackboard platform) of the course. All resources developed for the subject, such as slides, exercise statements and solutions, statements of problems for practices, detailed schedules for each group and class, mid-term exams

marks and any other information that teachers consider appropriate for the proper teaching and learning process will be available on the website.

If the student participates in only one or none of the evaluation activities proposed during the course, he or she will be considered as not having been presented.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

The teaching-learning methodology and the assessment process will be adapted as needed, in accordance with the guidelines of the Diversity Support Unit, to implement curricular adaptations for students with specific needs.

According to current regulations and because the experimental lab skills are considered essential for the acquisition of the objectives of the course, attendance **at all laboratory sessions and overcoming the mandatory practices is considered an essential element of the assessment, in both continuous and final modalities** (regulations governing the evaluation processes learning models -30 September 2021- Article 6, paragraph 4). For this reason, the laboratory exercises are common and essential in both types of evaluation: continuous and final.

In general, the continuous assessment system implies that the student attends regularly and punctually to class, and that delivers the required work on the agreed dates and demonstrates in the different evaluation procedures that he or she has acquired the corresponding skills and knowledge.

5.2. EVALUATION

EVALUATION CRITERIA.

The evaluation process aims at assessing the extent and depth of the student's acquisition of skills raised in the subject. Consequently, the evaluation criteria to be applied in the various tests that are part of the process, ensure that the student has the appropriate level in the following knowledge and skills:

Theoretical contents:

CE1: The student understands and knows the concepts and main ideas of each of the topics.

CE2: Knows how to relate theoretical contents to practical cases.

CE3: The student shows ability and initiative in solving the practical problems associated with power

electronics in a comprehensive way.

CE4: The student is able to develop, present and argue ideas in a coherent way, both orally and in writing.

CE5: The student is careful and rigorous in his/her approach when making presentations.

Practical contents:

CE6: The student succeeds in the interpretation of data, practical problems and practical experiments.

CE7: Successfully perform power system simulations.

CE8: Relate theory to practice properly.

CE9: Correctly makes laboratory experiments.

CE10: Is rigorous in making and interpreting measurements and results.

CE11: Presents consistent practical works within the available time.

CE12: Knows how to work in teams.

GRADING TOOLS

Below are the grading tools that will be applied to each of the qualification criteria, corresponding to the ordinary and extraordinary evaluation.

1) Continuous assessment: Students will be evaluated by continuous assessment throughout the semester. The type of tests to be performed and the percentages by weight of such evidence on the final grade are:

a) Laboratory sessions (PRL): Compulsory attendance. The sessions cover the knowledge acquired in the theoretical part of the course. Problems or practical cases that link theory with practice will also be resolved. There are two marks: the first comprises the assessment of activities carried out until mid-course (PRL1), the second those made in the second half of the course (PRL2). Each mark, PRL1 and PRL2, represent, each, 25% of the final grade of the student (50% overall). For each of the sections the following evaluation resources are used:

i) Exercises and written or oral follow-up work (EL): In order to promote the ongoing monitoring and formative student feedback, theroretical-practical exercises and questions related to the development of the laborartory practices will be proposed to the students to be solved in pairs or individually.

ii) Lab. Deliverable (PL): After each lab. half (PL1 for the first, PL2 for the second), students will deliver a document describing all analysis, simulations and problems.

iii) Laboratory tests (TCL): Two individual practical cases (TCL1 and TCL2) to solve using simulation tools.

The mark in each of the halves, PRL1 or PRL2, is divided into 30% for the deliverables together with a continuous evaluation mark, and 70% for the laboratory tests TCL1 and TCL2.

b) Mid-term evaluation tests (PEI), divided into two terms: the first comprises the tests until mid-course (PEI1: 25% of the final grade of the student); the second covers made from mid to end of year (PEI2: 25% of the final grade of the student). These tests consist of questions (analysis and / or synthesis) regarding specific aspects of the syllabus covered by the lectures and exercises.

2) Final assessment: Students have to pass two exams:

a) Theoretical-practical tests (PEF, 70%) widely covering the different subject contents. Mark will be NO PRESENTED if this test is not done.

b) Laboratory test (PRL, 30%) to evaluate the student work during the compulsory lab sessions.

GRADING CRITERIA

Ordinary continuous evaluation call

Competences	Learning Results	Evaluation criteria	Assessment Tool	Evaluation weights
TR2, TR3, CSE4, CSE5	RA1, RA2, RA3, RA4	CE1, CE2, CE3, CE4, CE5	PEI1	25%
TR2, TR3, CSE1, CSE4, CSE5, CSE9	RRA1, RA3, RA4	CE1, CE2, CE3, CE4, CE5	PEI2	25%
TR2, TR3, CSE5	RA4, RA5	CE6, CE7, CE8, CE9, CE10, CE11	PRL1	25%
TR2, TR3, CSE5, CSE1	RA4, RA6	CE6, CE7, CE8, CE9, CE10, CE11	PRL2	25%

Students will be considered to have passed the course (demonstrating the acquisition of theoretical and practical skills) following continuous assessment if the following requirements are met:

- Have successfully passed the assessment of laboratory practice related competencies and problems/practical assumptions. A student will be considered to have acquired these competences satisfactorily if his or her score in the set of related tests in each section, (PRL1 in the first part and PRL2 in the second), is equal to or greater than 35% of the maximum grade obtainable.
- They have successfully passed the evaluation of the competences related to all the theoretical tests. A student will be considered to have acquired these competences satisfactorily if his or her score in the set of related tests (PEI1 for the first part and PEI2 for the second part) is equal to or greater than 35% of the maximum score.
- The final weighted score of all the continuous assessment tests defined is equal to or greater than 5 out of 10.

As a part of the continuous evaluation, the student can choose to improve the score obtained in first part (PEI1 and first laboratory proof TCL1) at the end of the course, keeping the maximum obtained score.

If the student does not pass any of the parts (theoretical evidences and laboratory), the student will receive a failing grade of a numerical grade equal to the weighted average of all the continuous assessment tests, in any case always less than 5 points. For the extraordinary evaluation, the student can choose to keep the score of those parts whose competences have been acquired.

The student who follows the continuous assessment model will be considered as not presented in the ordinary call when he or she participates in only one or none of the assessment activities proposed throughout the course.

Ordinary final evaluation call

Competences	Learning Results	Evaluation criteria	Assessment Tool	Evaluation weights
TR2, TR3, CSE4, CSE5, CSE9, CSE1	RRA1, RA2, RA3, RA4	CE1, CE2, CE3, CE4, CE5	PEF	70%
TR2, TR3, CSE5, CSE1	RA4, RA5	CE6, CE7, CE8, CE9, CE10	PRL	30%

Students are considered to have passed the subject (demonstrating the acquisition of skills of theoretical and practical) following the final assessment if the following requirements are met:

- They have successfully passed the assessment of the skills related to the labs or problems and practical assumptions. It is understood that a student acquires these skills successfully, if he has attended to the lab and its rating in average for all the related tests is, at least, 35% of maximum score obtainable.
- They have successfully passed the assessment of skills related to theoretical and practical tests. It is understood that a student has successfully acquired these skills, if his score in average in all the related tests is at least 35% of the maximum qualifying.
- The final weighted score assessment is equal to or greater than 5 out of 10.

In the event of failure to pass any of the parts (theoretical evidences or laboratory), the student will receive a failing grade of a numerical grade equal to the weighted average of all the continuous assessment tests, in any case always less than 5 points.

Extraordinary exam

For both continuous and final assessment, the relationship between the criteria, instruments and rating is the same as in the ordinary exam, as described above.

1) Continuous assessment: Students who, having participated in the process of continuous assessment have not achieved a final grade higher than 5 out of 10 in the ordinary exam may keep the passed parts marks and prepare only for the failed in the extraordinary exam. Students who have been negatively evaluated in the laboratory practices and problems or practical cases in the ordinary call can make specific theoretical and practical tests to demonstrate the acquisition of those skills and competences.

2) Final assessment: The assessment and marking procedure is equal to the ordinary one.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Documentation generated by teachers for the course, which will be provided to students directly, or posted on the course Web site.
- N. Mohan, T. M. Undeland y W. P. Robbins. “Power Electronics: Converters, Applications, and Design”. Ed. John Wiley&Sons, Inc. 2002. ISBN: 0-471-58408-8.
- This book is the main reference for the subject. It covers nearly all the topics and is also valid as a complementary reference.
- A. Barrado, A. Lázaro. “Problemas de Electrónica de Potencia”. Ed. Pearson - Prentice Hall. 2007. ISBN: 9788420546520. Good solved-problems book. In spanish.

6.2. Additional Bibliography

- R. W. Erickson, D. Maksimovic. “Fundamental of Power Electronics”.Second Edition.Ed. Springer Science+Business Media Inc. 2001.ISBN: 0-7923-7270-0 http://ecee.colorado.edu/~pwrelect/book/SecEd.html.
- Well known reference book for power electronic converters analysis and design. From the equilibrium and dynamical point of view.
- Daniel W. Hart. “Introduction to Power Electronics”.Ed. Prentice Hall. Edición internacional, 1997. ISBN: 0-13-180415-4. http://diamond.gem.valpo.edu/~dhart/ (also available in spanish). Good

reference book.

Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.