Universidad Zaragoza

**Academic Year/course: 2022/23**

# 28822 - Power Grids and Electric Machines

## Syllabus Information

**Academic Year:** 2022/23
**Subject:** 28822 - Power Grids and Electric Machines
**Faculty / School:** 175 - Escuela Universitaria Politécnica de La Almunia
**Degree:** 424 - Bachelor's Degree in Mechatronic Engineering
**ECTS:** 6.0
**Year:** 3
**Semester:** First semester
**Subject Type:** Compulsory
**Module:**

# 1. General information

## 1.1. Aims of the course

The subject and its expected results respond to the following approaches and objectives:
- Show the concepts and development of the three-phase systems of alternating current, studying them the different types of resulting circuits, from the analysis of networks.
- Introduce fundamental concepts about the electrical power system, classification of networks, as well as types of lines and conductors. Calculate the section of the conductors of the electric lines and assess their importance from a technical point of view and without losing sight of economic aspects.
- Determine the operation of the magnetic circuit and use it as a link between the theory of electrical circuits and electric machines.- Show the general principles of electric machines. To deepen in the knowledge of the static electrical machines (transformer) and dynamic machines (DC and asynchronous machines).
- Make known the existing regulations on low and high voltage.

- Use software to make electrical diagrams.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDG) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/es/), in such a way that the acquisition of the results of Subject learning provides training and competence to contribute to some extent to its achievement:

- Goal 7: Guarantee access to affordable, safe, sustainable and modern energy.

And, specifically, with the target:

- Target 7.1: By 2030, ensure universal access to affordable, reliable and modern energy services.

## 1.2. Context and importance of this course in the degree

The subject of Electrotechnics is part of the Degree in Mechatronic Engineering taught by EUPLA, framed within the group of subjects that make up the module called Electricity and Electronics and within this to the subject of Electrical Technology. It is a third year subject and compulsory in the fifth semester, with a teaching load of 6 ECTS credits.
It is understood that the student accesses the previous knowledge acquired in previous studies, which serve as the basis, being able to quote those related to the theory of electric and magnetic fields, the theory of electrical circuits, mathematics, physics, drawing, chemistry, etc.
This subject implies an important impact in the acquisition of the competences of the degree, in addition to providing additional useful training in the performance of the Mechatronic Engineer's functions related to the field of electricity.

## 1.3. Recommendations to take this course

The development of the subject Electrotechnics requires putting into play knowledge and strategies from subjects related to:
- Technical drawing: Graphic resources and expression techniques are an essential tool to express technical ideas. The views, plans and circuit diagrams are documents commonly used in Electrical engineering.
- Physics: Knowledge of the principles and laws of electromagnetism allows understanding the operation of the elements, devices and systems under study in Electrical Engineering.
- Chemistry: Knowing the structure of matter and some chemical phenomena, helps advance in the study of Electrical Engineering
- Mathematics: Theorems, algorithms and strategies learned in this discipline, are of essential use in the approach and resolution of all calculations that are carried out in Electrical engineering.
- Electrical Engineering: Fundamental subject, which reveals the theorems and the necessary methodology to understand the behaviour of the elements, devices and systems under study in Electrotechnics.
In relation to the above, in the first and second year of the degree, and in advance subjects related to these subjects are studied, providing the basic knowledge to be able to follow without any type of problem the evolution of the subject in

q u e s t i o n .
This subject does not possess any normative prerequisite nor does it require specific complementary knowledge. Therefore, the aforementioned is understood from a formal point of view, although it is advisable to have studied the subjects related to the above-mentioned subjects before taking the subject of Electrotechnics.

# 2. Learning goals

## 2.1. Competences

**Upon passing the subject, the student will be more competent to ...**

- GI03: Knowledge of basic and technological subjects, which enables them to learn new methods and theories, and equips them with versatility to adapt to new situations.

- GI04: The ability to solve problems with initiative, decision making, creativity, critical reasoning and to communicate and transmit knowledge, abilities and skills in the field of Industrial Engineering and in particular in the field of industrial electronics.

- GI06: The ability to manage mandatory specifications, regulations and standards.

- GC02: Interpret experimental data, contrast them with the theoretical ones and draw conclusions.

- GC04: The ability to learn continuously, self-directed and autonomously.

- GC05: The ability to evaluate alternatives.

- GC07: The ability to lead a team as well as to be a committed member of it.

- GC08: The ability to locate technical information, as well as its understanding and evaluation.

- GC10: The ability to write technical documentation and to present it with the help of appropriate computer tools.

- GC11: The ability to communicate your reasoning and designs clearly to specialized and non-specialized audiences.

- GC14: The ability to understand the operation and develop the maintenance of mechanical, electrical and electronic equipment and installations.

- EI04: Knowledge and use of the principles of circuit theory and electrical machines.

- EE01: Applied knowledge of electrical engineering.

## 2.2. Learning goals

**The student, to pass this subject, must demonstrate the following results ...**

- Choose and properly use the electrical measurement devices, assessing their degree of precision.

- Analyze the operation of electrical circuits depending on the type of supply, number of phases, nature of the load and types of connection in permanent regime.

- Know fundamental concepts about the electrical power system, classification of networks, as well as types of lines and conductors. Calculate the section of the conductors of power lines and assess their importance from a technical point of view and without losing sight of economic aspects.

- Define the basic principles and applications of the most common transformers and electric motors.

- Determination of the operation and behavior of an electrical machine based on its equivalent circuit.

- Select and interpret adequate information to propose and assess solutions, in the field of electrical engineering, to different technical problems.

- Know aspects related to the generation, transport and distribution of electrical energy.

- Preparation and interpretation of plans and diagrams based on the appropriate regulations and symbols.

- Realization of electrical diagrams through the use of specific software.

## 2.3. Importance of learning goals

Through the achievement of the relevant learning results of this subject, the student will acquire the necessary capacity to understand the operation of circuits, installations and electrical machines, to handle basic electrical instrumentation, as well as to use the terminology of electrical engineering. On the other hand, the student will obtain the ability to evaluate and prevent risks, both their own and those of their dependents, when working with electrical installations and machines.

This course, which has a marked engineering character, lays the necessary foundations for the development of future subjects taught after the degree, both compulsory and optional, as well as offering training with content for application and immediate development in the labor and professional market. .

The skills acquired through it are essential for the design and implementation of any application, plant, process, system, mechanism, etc. included within the scope of Mechatronic Engineering.

# 3. Assessment (1st and 2nd call)

## 3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

**The student must demonstrate that they have achieved the expected learning outcomes through the following assessment activities**

# Continuos assessment system.

Following the spirit of Bologna, regarding the degree of involvement and continued work of the student throughout the course, the evaluation of the subject contemplates the continuous evaluation system, as the most consistent to be in line with the guidelines set by the new EEES framework.

The continuous assessment system will have the following group of qualifying activities:

- **Individual activities in class**: Active participation in the entire teaching-learning process, the public presentation of works and the resolution of theoretical and practical exercises in class will contribute 10 % to the final grade for the subject.

- **Laboratory sessions**: Practices corresponding to each of the subjects susceptible of it will be carried out, which will serve to assimilate and apply the concepts seen in the theory and acquire the relevant skills. These practices will be carried out in groups of students, taking into account that in addition to verifying its correct operation, a memory must be prepared, the format of which will be provided by the teacher and which must be submitted for correction in the next class. The memories of the practices, if they are delivered correctly, completely and within the required time period, will contribute 15 % to the final grade for the subject. The realization of these practices and their learning are compulsory for all, therefore they will be part of the global assessment test. If any student is unable to attend the practical classes, they will subsequently have to do them during the extraordinary hours determined for this purpose.

- **Exercises, theoretical questions and proposed works**: The teacher will propose exercises, problems, practical cases, theoretical questions, works, etc. to be solved individually or in a group of maximum students. Said activity will contribute 15 % to the final grade for the subject. To take this grade into account, the works must be delivered on the dates set.

- **Written examinations**: They will be carried out in order to regulate learning, stimulate the distribution of effort over time and have a more individualized evaluation tool of the educational process. These tests will collect theoretical and / or practical questions, of the different subjects to evaluate, their total number will be two distributed throughout the whole semester. This activity will contribute 60 % to the final grade for the subject.

As a summary of the above, the following weighting table of the grading process of the different activities has been designed, in which the continuous evaluation system of the subject has been structured.

| Continuous assessment system activity | Weighing |
|---|---|
| Individual activities in class | 10 % |
| Laboratory sessions | 15 % |
| Exercises, theoretical questions and proposed works | 15 % |
| Written examinations | 60 % |

Prior to the first call, the teacher of the subject will notify each student whether or not they have passed the subject based on the use of the continuous assessment system, based on the sum of the scores obtained in the different activities carried out throughout thereof, each contributing a minimum of 50 %. In case of not passing in this way, the student will have two additional calls to do so (global assessment system), on the other hand, the student who has passed the course through this dynamic, may also choose the global assessment test, in first call, to upload note but never to download.

The evaluation criteria to be followed for the activities of the continuous assessement system are:

- **Individual activities in class**: The active participation of the student will be taken into account, answering the questions promptly posed by the teacher in the daily course of the class, their fluency and oral expression when presenting the works in public and the qualification of the theoretical-practical exercises proposed and collected on site. All the activities will contribute in the same proportion to the total mark of said block, being valued from 0 to 10 points.*At least 80 % of said activities must be carried out to qualify for the continuous assessement system.*

- **Laboratory sessions**: In each one of the practices the dynamics followed for its correct execution and operation will be valued, as well as the problems raised in its development, the specific weight of this section being 30 % of the total mark of the practice. The remaining 70 % will be dedicated to the qualification of the report presented, that is, if the required data is correct and the questions asked have been answered correctly. The score of each practice will be from 0 to 10 points and never less than 5, since if it is not considered suspended and will have to be repeated, correcting what is not correct. The final grade for all the practices will be the arithmetic mean of all of them.

- **Exercises, theoretical questions and proposed works**: Their approach and correct development, the writing and coherence of what is discussed, as well as the achievement of results and the final conclusions obtained, will be scored from 0 to 10 points.

- **Written examinations**: They will consist of the typical written exam scored from 0 to 10 points. The final grade of said activity will be given by the arithmetic mean of said tests, as long as there is no unit grade of less than 3 points, in this case the activity will be suspended. The approach and the correct resolution will be valued, as well as the justification of the methodology used when solving the exercises. Particularizing, for each of the tests will have the following:

? **Examination 1**: It will consist of three practical exercises, the first of them will consist of the resolution of a three-phase network with single-phase and / or three-phase receivers, the second of a direct current line and the third of a three-phase. The contribution of the first year to the total grade will be 30 %, 35 % being reserved for the second and third, respectively.

? **Examination 2**: It will consist of three practical exercises, the first of which will consist of solving a three-phase transformer, the second of a DC motor and the third of a three-phase asynchronous motor. The contribution of each exercise to the total mark of the test will be 33.33 %.

# Global assessment system.

The student must opt for this modality when, due to their personal situation, they cannot adapt to the rhythm of work required in the continuous assessment system, have suspended or want to increase their grade having participated in said evaluation methodology.

As in the previous assessment methodology, the global assessment system must be aimed at verifying whether the learning results have been achieved, as well as contributing to the acquisition of the various competences, and should be carried out through more objective activities if possible.

The global assessment systemt will have the following group of qualifying activities:

- **Laboratory sessions**: They will have to be carried out integrated within the schedule of continuous evaluation. If this is not possible, they can be carried out during special laboratory hours to be specified during the semester. Likewise, they will contribute 15 % to the final grade of the evaluation.

- **Exercises, theoretical questions and proposed works**: The teacher will propose exercises, problems, practical cases, theoretical questions, works, etc. to be solved individually, being delivered on the date set for this purpose. This activity will contribute 15 % to the final grade for the subject.

- **Written exam**: Consists of solving exercises of theoretical and / or practical application with similar characteristics to those solved during the conventional development of the subject. This exam will be unique with representative exercises of the topics, contributing 70 % to the final grade for the subject.

As a summary of the above, the following weighting table of the grading process of the different activities has been designed in which the global assessment system of the subject has been structured.

| Global assessment system activity | Weighing |
|---|---|
| Laboratory sessions | 15 % |
| Exercises, theoretical questions and proposed works | 15 % |
| Written exam | 70 % |

The subject will have been passed based on the sum of the scores obtained in the different activities carried out, each contributing a minimum of 50 %.

For those students who have suspended the continuous assessment system, but some of their activities, with the exception of the written examinations, have been carried out may promote them to the global assessment system, and it may be the case that they only have to take the written exam.

All the activities included in the global assessment system, with the exception of the written exam, may be promoted to the next official call, within the same academic year.

The evaluation criteria to be followed for the activities of the global assessment system will be the same as those defined for the continuous assessment system, bearing in mind that the written exam will consist of five practical exercises, the first of which will consist of solving of a direct current line, the second a three-phase alternating current line, the third of a three-phase transformer, the body of a direct-current motor and the fifth of a three-phase asynchronous motor. The contribution of each of them to the total grade will be the same, that is, 20 %.

## 4. Methodology, learning tasks, syllabus and resources

### 4.1. Methodological overview

The learning process designed for this subject is based on the following:

In a strong teacher/student interaction. This interaction is materialized through the distribution of work and responsibilities between students and teachers. However, it will have to be taken into account that to a certain extent students can mark their learning pace according to their needs and availability, following the guidelines set by the teacher. The present subject of Electrical Engineering is conceived as a unique set of contents but worked under three fundamental and complementary forms as they are: the theoretical concepts of each didactic unit, the resolution of problems or questions and the laboratory practices, supported in turn For another series of activities. The organization of the teaching will be carried out following the following guidelines:

**- Lectures**: Theoretical activities carried out mainly through exposition by the teacher, where the theoretical supports of the subject are displayed, highlighting the fundamentals, structuring them in topics and or sections, interrelating them.

- **Practice sessions**: The teacher resolves practical problems or cases for demonstrative purposes. This type of teaching complements the theory shown in the lectures with practical aspects.

- **Laboratory sessions**: The lecture group is divided up into various groups, according to the number of registered students, in order to make up smaller sized groups.

**- Group tutorials**: Programmed activities of learning follow-up in which the teacher meets with a group of students to guide their work of autonomous learning and supervision of works directed or requiring a very high degree of advice by the teacher.

- **Individual tutorials**: Those carried out giving individual, personalized attention with a teacher from the department. Said tutorials may be in person or online.

The approach, methodology and assessment of this guide are intended to be the same for any teaching scenarios. They will be adapted to the social-health situation at any particular time, as well as to the instructions given by the authorities concerned.

## 4.2. Learning tasks

The course involves the active participation of the student, in a way that the results achieved in the learning process are developed, not taking away from those already set out, the activities are the following:

- **Face-to-face generic activities**:

? Theory Classes: The theoretical concepts of the subject are explained and illustrative examples are developed as a support to the theory when necessary.

? Practical Classes: Problems and practical cases are carried out, complementary to the theoretical concepts studied.

? Laboratory Workshop: This work is tutored by a teacher, in groups.

- **Generic non-class activities**:

? Study and understanding of the theory taught in the lectures.

? Understanding and assimilation of the problems and practical cases solved in the practical classes.

? Preparation of seminars, solutions to proposed problems, etc.

? Preparation of laboratory workshops, preparation of summaries and reports.

? Preparation of the written tests for continuous assessment and final exams.

**-Tutored autonomous activities.**

Although they will have more of a face character that has been taken into account in part for their idiosyncrasies, they will be primarily focused on seminars and tutorials under the supervision of the teacher.

- **Reinforcement activities.**

Non-contact marking character, through a virtual learning portal (Moodle) various activities that reinforce the basic contents of the subject be addressed. These activities can be customized or not, controlling their realization through it.

## 4.3. Syllabus

The subject program is structured around two components of complementary content:

- Theory.
- Practice.

**THEORETICAL CONTENTS.**

The theoretical contents are articulated based on eight teaching units attached relationship, indivisible blocks of treatment, given the configuration of the subject that program. These topics collect the contents needed for the acquisition of predetermined learning outcomes.

- TOPIC 1: Three-phase sinusoidal alternating current.

- TOPIC 2: Direct current lines.

- TOPIC 3: Single phase alternating current lines.

- TOPIC 4: Three-phase alternating current lines.

- TOPIC 5: Single-phase transformers.

- TOPIC 6: Three-phase transformers.

- TOPIC 7: Direct current motors.

- TOPIC 8: Three-phase asynchronous motors.

**PRACTICAL CONTENTS.**

Laboratory session related to electrical measurements and automatics will be carried out.

## 4.4. Course planning and calendar

The subject has 6 ECTS credits, which represents 150 hours of student work in the subject during the trimester, in other words, 10 hours per week for 15 weeks of class.

A summary of a weekly timetable guide can be seen in the following table. These figures are obtained from the subject file in the Accreditation Report of the degree, taking into account the level of experimentation considered for the said subject is moderate.

| Activity | Weekly school hours |
|---|---|
| Lectures | 3 |
| Laboratory | 1 |
| Others activities | 6 |

Nevertheless, the previous table can be shown in greater detail, taking into account the following overall distribution:

? 45 hours of lectures, with 50 % theoretical demonstration and 50 % solving type problems.

? 10 hours of laboratory workshop, in 1 or 2-hour sessions.

? 5 hours of written assessment tests, one or two hours per test.

? 90 hours of personal study, divided up over the 15 weeks of the semester.

Written continuous assessment tests are related to the following topics:

? **Written assessment examination 1**: Topics 1, 2, 3 y 4.

? **Written assessment examination 2**: Topics 5, 6, 7 y 8.

The topics on which the works will be developed will be proposed in the third week, with their delivery and exhibition being carried out before the last two teaching weeks, during the course of the signature the dates will be specified.

The most significant dates of the continuous evaluation system will be published in Moodle during the development of the course.
The dates of the global evaluation test will be those published officially on the School website: https://eupla.unizar.es/asuntos-academicos/examenes.

The weekly schedule of the subject will be published officially on the School website:
https://eupla.unizar.es/grado-en-ingenieria-mecatronica.

## 4.5. Bibliography and recommended resources

Resources and materials used in the development of the subject are reflected in the following table:

| Material | Format |
|---|---|
| Topic theory notes<br>Topic problems | Paper/repository |
| Topic theory notes<br>Topic presentations<br>Topic problems<br>Related links | Digital/Moodle<br>E-Mail |
| Software | Pc?s laboratory |
| Technical manuals | Paper/repository<br>Digital/Moodle |
| Multimeters<br>ammeters<br>Voltmeters<br>Power Meters<br>Frequency<br>Transformers<br>Rectifiers<br>Oscilloscopes<br>Single and three phase loads<br>Engines<br>Electrical switchgear | |

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=28822