Universidad Zaragoza

Academic Year/course: 2021/22

28812 - Electrical Engineering

Syllabus Information

Academic Year: 2021/22
Subject: 28812 - Electrical Engineering
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
Degree: 424 - Bachelor's Degree in Mechatronic Engineering
ECTS: 6.0
Year: 2
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The subject and its results respond to the following approaches and objectives: Show the basic concepts of the theory of electrical circuits and the study of the different types of circuits resulting, the results in the analysis of networks, according to the nature of the power supply. If the source is invariable in time, the circuits of the direct current are studied, while the sinusoidal constant current alternating current circuits are studied in the sinusoidal.

The following general objectives of the subject are:

- Have the students practice the analytical techniques developed in the subject.
- Show students that analytical techniques are tools, not objectives in themselves.
- Allow students to practice in the choice of the most appropriate analytical method to obtain a specific solution.
- Show students how the results of a solution can be used to find other information about the operation of a circuit.
- Encourage students to check the solutions, as well as an alternative method or checking if the solution makes sense according to the known behavior of the circuit.
- Make students begin to become familiar with design-oriented problems.
- Having students practice in the deduction and handling of the equations in the magnitudes of interest are expressed as functions of circuit variables such as R, L, C, etc.; these types of problems also serve to support the design process.
- Show the general principles of electric machines. Introduce in the knowledge of electric machines.

These approaches and objectives are in line with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/es/), in such a way that the acquisition of the course learning outcomes provides training and competence to contribute to their achievement to some degree:

- **4.4** By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.
- **4.7** By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture?s contribution to sustainable development.
- **9.1** Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
- **9.4** By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
- **12.2** By 2030, achieve the sustainable management and efficient use of natural resources.
- **12.5** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

1.2. Context and importance of this course in the degree

The Electrical Engineering course 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. It is a subject of the second year of compulsory education (OB), with a teaching load of 6 ECTS credits. This subject involves a more than the discrete impact on the acquisition of the skills of the degree, in addition to providing additional useful training in the performance of the functions of the Mechatronic Engineer related to the field of electricity.

The need for the subject within the curriculum of the present degree is more than justified and it is understood that the ideal would be that, as a student, this subject will be started with clear ideas about what an electric circuit is, what components it has, as well as the physics that lies behind it, that is, the theory of electric and magnetic fields, previous knowledge acquired in previous studies.

1.3. Recommendations to take this course

The development of the Electrical Engineering subject requires putting into play knowledge and strategies from subjects related to:

Technical drawing, Physics, Mathematics.

However, it is not a legal requirement to have passed them in order to join Electrical Engineering.

2. Learning goals

2.1. Competences

Upon passing the subject, the student will be more competent to:

- **(GI03):** Manage knowledge in basic and technological subjects, which enables them to learn new methods and theories, and equips them with versatility to adapt to new situations.
- **(GI04):** Having 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
- **(GI05):** Have the capacity to handle specifications, regulations and mandatory standards.
- **(GC02):** Interpret experimental data, contrast them with the theoretical ones and draw conclusions

- **(GC03):** Have the capacity for abstraction and logical reasoning.
- **(GC04):** Have the ability to learn continuously, self-directed and autonomously.
- **(GC05):** Have the ability to evaluate alternatives.
- **(GC07):** Having the ability to lead a team as well as being a committed member of it.
- **(GC08):** Have the ability to locate technical information, as well as its understanding and evaluation.
- **(GC10):** Be able to write technical documentation and present it with the help of appropriate computer tools.
- **(GC11):** Have the ability to communicate their reasoning and designs clearly to specialized and non-specialized audiences.
- **(GC14):** Have the capacity to understand the operation and develop the maintenance of mechanical, electrical and electronic equipment and installations.
- **(CE21):** Know and use the principles of circuit theory and electrical machines.

2.2. Learning goals

In order to pass this subject, must show the following results:

- To explain the behavior of simple electrical devices, as well as the underlying physical laws and principles, using appropriate vocabulary, symbols, and forms of expression.
- To select and correctly use the components of an electrical circuit that meets a predetermined purpose, including its operation.
- To handle the instruments of a laboratory of electrical circuits, assessing their degree of precision.
- To explain and use the fundamentals of circuit theory and electrical machines
- To apply the principles of circuit theory to the analysis of simple problems.
- To analyze electrical circuits in permanent sinusoidal regime and in transitory regime.
- To analyze the response of electrical circuits conceptually and analytically from the point of view of energy and power.
- To analyze and interpret the response of magnetically coupled electrical circuits.
- To apply the principles of electrical machines to the analysis of simple problems.
- To know how to use the general methodology and the appropriate software tools to work in circuit analysis.

2.3. Importance of learning goals

This subject has a marked engineering character, that is, it offers training with application content and immediate development in the labor and professional market. Through the achievement of the relevant learning results, the necessary capacity is obtained to understand the operation of electrical circuits and machines, which will be absolutely essential for the design and start-up of any application, plant, process, 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:

General concepts:

Assessment is a basic element in the entire teaching-learning process, since the only mechanism that allows, at any time during an educational period, to detect the degree of achievement of the proposed learning results and, if appropriate, apply the necessary corrections. .

The evaluation must be understood as a continuous and individualized process throughout the entire teaching-learning period, prioritizing the capacities and abilities of each student, as well as their performance.

The evaluation process will include two types of action:

- Continuous assessment system, which will be carried out throughout the learning period.

- Global assessment test, reflecting the achievement of learning results, at the end of the teaching period.

These evaluative processes will be carried out through:

- Direct observation of the student to know their attitude towards the subject and the work that it requires (attention in class, completion of assigned tasks, resolution of questions and problems, active participation in the classroom, etc.).
- Direct observation of skills and abilities in laboratory work.
- Checking their progress in the conceptual field (questions in class, comments in the classroom, taking exams, etc.).
- Periodic performance of written and / or oral tests to assess the degree of knowledge acquired, as well as the qualities of expression that, at this educational level, must be widely demonstrated.

Continuous evaluation 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 considers the continuous evaluation method as the most appropriate to be in accordance with the guidelines set by the new framework from the EHEA. To opt for the Continuous Assessment system, the student must attend at least 80% of the face-to-face activities (theoretical / practical classes, laboratory practices, technical visits, etc.), for which purpose an attendance control by the teacher.

The continuous evaluation process will have the following group of qualifying activities:

- **Laboratory practices:** 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. In the development of these practices, it should be borne in mind that in addition to verifying their 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 period of time, will contribute 20% to the final grade for the course, as long as there is no unit grade below 4.0 points. The realization of the practices and their learning are MANDATORY for all (minimum attendance 80%), therefore they will be part of the final evaluation exam if they had not been carried out. If any student is unable to attend the practical classes, they must take them during the extraordinary hours determined for this purpose.
- **Exercises, theoretical questions and proposed works:** Depending on the dates available, the teacher will propose exercises, problems, practical cases, theoretical questions, etc. to be solved individually or in groups of several students (the number of students per group will depend on the number of students enrolled in the subject). A part of them can be discussed, resolved, etc., in seminars proposed for this purpose, as well as in tutorials with the teacher. Said activity will contribute a maximum of 20% to the final grade for the course. To take this grade into account, the papers must be handed in on the marked dates, attend all the seminars and, if there is a justified reason, attend the group tutoring with the teacher.
- **Public exhibition of works:** Once the laboratory groups are established, the group works will be distributed concerning topics related to this subject (mainly, Electrical Machines) as well as other subjects in the electronics branch (Analog Electronics, Digital, Power or Instrumentation). The groups will work during the semester informing the teacher of their progress and problems, and will present their work to their classmates the last week of the course. These works and exhibitions are mandatory and will account for 20% of the final grade, as long as there is no unit grade below 4.0 points.
- **Partial written tests:** 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 three, distributed throughout the entire semester with a minimum duration of one class and a maximum of two, depending on the case, and evaluated 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 below 4.0 points. This activity will contribute between 40% and 60% to the final grade for the course.

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 continuous assessment, based on the sum of the scores obtained in the different activities carried out throughout the same. In case of not passing in this way, the student will have two additional calls to do so (final evaluation), on the other hand, the student who has passed the course through this dynamic, may also choose the global assessment test, in the first call , to upload note but never to download.

The evaluation criteria to be followed for the activities of the continuous evaluation 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 activities will contribute in the same proportion to the total mark of said block, being valued from 0 to 10 points.
- **Laboratory practices:** 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 final grade for all the practices will be the arithmetic mean of all of them. The student will be able to use the laboratory for the recovery of suspended / unfinished practices depending on its availability.
- **Exercises, theoretical questions and proposed works:** Their approach and correct development, the writing and coherence of the treated will be valued, as well as the achievement of results and the final conclusions obtained.
- **Written assessment tests (partial exam):** They will consist of the typical written exam, scored from 0 to 10 points. The final grade for this activity will be given by the arithmetic mean of said tests, as long as there is no unit grade below 4.0 points. In this case, the activity will be suspended and pending evaluation on call. The approach and the correct resolution will be valued, as well as the justification of the methodology used when solving the exercises. For each of the tests you will have the following:
- **Test 1:** (Topics 1 to 4). It will consist of a series of exercises aimed at basic circuit analysis.
- **Test 2:** (Topics 5 to 7). There will be a series of exercises oriented to the analysis and / or design of circuits in single and three-phase RPS.

Global assessment:

The student must choose this modality when, due to their personal situation, they cannot adapt to the rhythm of work required in the continuous evaluation mode, they have suspended or would like to get a grade having participated in said evaluation methodology. As in the previous evaluation methodology, the final evaluation 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 evaluation process will have the following group of qualifying activities:

- **Laboratory practices:** They will have to be carried out integrated within the continuous evaluation schedule. If this is not possible, they can be carried out during special laboratory hours to be specified during the semester. Likewise, they will contribute 20% to the final grade for the evaluation, as long as there is no unit grade below 4.0 points.
- **Public exhibition of works:** The professor will propose theoretical-practical works to be solved and defended in a group, being delivered on the date set for this purpose. This activity will contribute 20% to the final grade for the course, as long as there is no unit grade below 4.0 points.
- **Written exam:** Due to the type of subject, with problems of medium complexity and reasonable resolution times, the most appropriate type of test is the one consisting of solving exercises of theoretical and / or practical application with similar characteristics to those solved during the conventional development of the subject, carried out over a period of three hours. This test will be unique with representative exercises for each topic, evaluated from 0 to 10 points and contributing 60% to the final grade for the course, as long as there is no unit grade below 4.0 points.

For those students who have failed the global assessment test but some of their activities, with the exception of the written assessment tests, have been carried out successfully, these may be promoted up to the final assessment, and it may be the case that they only have than take the written exam. All the activities included in the global assessment test, with the exception of the written exam, may be promoted to the next official call, **within the same academic year**.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

This Maintenance Management course is designed as a set of contents distributed in four blocks. The first block, brings together basic concepts, which perhaps students in many cases have already acquired. The second and third blocks form the core of the subject that the subject must contribute to

its training. The final block, brings together complementary knowledge to complete the training in Maintenance.

The first three blocks will be dealt with under three fundamental and complementary ways: the theoretical concepts of each didactic unit, the resolution of problems or questions and practices, supported in turn by another series of activities such as tutorials and seminars and will be tested individually, regardless of the blocks.

The fourth block will have a different treatment, because the students will work in groups only previously assigned sections, they will be able to express their preferences but all the subjects will have to be assigned to some group. They will prepare presentation materials and defend their work with a public presentation, which will be valued by the rest of the students and the teacher.

The teacher / student interaction is carried out in this way, through a distribution of work and responsibilities between students and teachers. However, it must be taken into account that, to a certain extent, students can set the pace of learning according to their needs and availability, following the guidelines set by the teacher.

The organization of teaching involves the active participation of the student, and will be carried out following the following guidelines:

- **Lectures:** Theoretical activities imparted in a fundamentally expositive way by the teacher, in such a way as to expose the theoretical supports of the subject, highlighting the fundamental, structuring the concepts and relating them to each other. If classroom teaching were not possible due to health reasons, it would be carried out on-line.
- **Practice Sessions:** The teacher solves problems or practical cases for illustrative purposes. This type of teaching complements the theory explained in the lectures with practical aspects. If classroom teaching were not possible due to health reasons, it would be carried out on-line.
- **Seminars:** The total group of lectures or practical lessons may or may not be divided into smaller groups, as appropriate. They will be used to analyze cases, solve problems, etc. Unlike what happens with the practical lessons, the teacher is not a protagonist, simply listening, counseling, clarifying, evaluating, assessing. It seeks to encourage student participation, as well as making the continuous assessment of students possible and to learn about the performance of learning.
- **Practice tasks:** Practice tasks are carried out in groups of two students (or three students at the most), although for the report of the activities (according to the teacher) homonymous groups of different shifts can be associated to encourage teamwork. If classroom teaching were not possible due to health reasons, it would be carried out on-line.
- **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 high degree of advice by the teacher.
- **Individual tutorials:** These are the ones made through the individual attention of the teacher in the department. They aim to help solve the doubts that students come across, particularly those who for various reasons cannot attend group tutorials or need more personalized attention. These tutorials can be in person or online.

4.2. Learning tasks

Generic on-site activities:

- **Lectures:** The theoretical concepts of the subject will be explained and illustrative practical

examples will be developed as a support for the theory when it is deemed necessary.

- **Practice sessions:** Problems and practical cases will be made as a complement to the theoretical concepts studied.
- **Practical tasks:** Students will be divided into several groups of no more than 20 students, being guided by the tutorial action of the teacher.
- **Defense and presentation of topics:** on the particular contents that are assigned to each group of students, corresponding to Block 4.

Generic off-site activities:

- Study and assimilation of the theory explained in the lectures.
- Understanding and assimilation of solved cases in practical lessons.
- Preparation of seminars, solving suggested problems, etc.
- Participation in Forums of the subject via Moodle, to provide links of information on the Internet.
- Preparation and development of scripts and corresponding reports.
- Preparation of written continuous assessment tests, and global assessment tests.

Autonomous tutored activities: Although they will be done on-site, they have been taken into account separately because of their particular features, they will be focused mainly on seminars and tutorials under the supervision of the teacher.

Reinforcement activities: Off-site activities preferably, via the virtual portal of teaching (Moodle), will be designed to reinforce the basic contents of the subject. These activities can be personalized or not.

4.3. Syllabus

The course is structured around two complementary components: theoretical and practical. The concepts and fundamentals of electrical circuit analysis, illustrated with actual examples, will be presented. Student participation through questions and brief discussions will be encouraged.

The contents of the theoretical classes are the following:

Topic I: Basic concepts.

- Introduction.
- IS units.
- Definitions.

Topic II: Elements of an electric circuit.

- Introduction.
- Active elements. Power sources.
- Passive elements. Resistors.
- Passive elements. Capacitors.
- Passive elements. Coils.
- Ideal and non- ideal sources.

Topic III: Fundamental concepts and laws.

- Introduction.
- Ohm's law.
- Notation, references and properties.
- Basic definitions.
- Kirchhoff's law of currents.
- Kirchhoff's law of tensions.

Topic IV: Circuit analysis techniques.

- Introduction.
- Analysis of circuits by nodes.
- Analysis of circuits by meshes.
- Divider circuits.
- Component groupings.
- Equivalence between sources.
- Thévenin and Norton equivalents.
- Other circuit theorems.

Topic V: Single phase AC in Sinusoidal Permanent Regime.

- Introduction and considerations.
- Sinusoidal signal: representation.
- Phasor concept.
- Phasor relations for R, L and C.
- General Ohm's law.
- Kirchhoff on frequency.
- Phasor diagrams.
- Basic examples.

Topic VI: Power in Permanent Sinusoidal Regime.

- Introduction.
- Instantaneous power.
- Active power.
- Apparent power and power factor.
- Reactive power.
- Final considerations.

Topic VII: Analysis in the time domain (I): first order circuits.

- Introduction.
- Simple RL circuit.
- Simple RC circuit.
- Exponential response: properties.
- General RL circuit.
- General RC circuit.

Topic VIII: Fundamental principles of electrical machines.

- Introduction.
- Basics of electrical machines.
- Types of electrical machines. General classification.

- Main characteristics of electrical machines.
- Performance and loss of electrical machines.
- Electromotive force induced in the windings.
- Electromagnetic torque.

4.4. Course planning and calendar

Lectures and problem resolution classes and laboratory workshops are according to the schedule set by the centre, which must be published before the start date of classes (http://www.eupla.es/).

The teacher will inform about his hours of tutoring.

Other activities will be planned depending on the number of students and will be announced with time. It will be available on https://moodle.unizar.es/

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=28812