VNIVERSITAT DE VALÈNCIA

Course Guide
34927 Principles of electrical engineering and electronics

COURSE DATA

Data Subject	
Code	34927
Name	Principles of electrical engineering and electronics
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1404 - Degree in Industrial Electronic Engineering	School of Engineering	1	Second term

Subject-matter

Degree	Subject-matter	Character
1404 - Degree in Industrial Electronic Engineering	11 - Foundations of electrotechnics and electronics	Obligatory

Coordination

Name	Department
GOMEZ SANCHIS, JUAN	242 - Electronic Engineering
SUAREZ ALVAREZ, ISAAC	242 - Electronic Engineering

SUMMARY

This course is part of the subject "Fundamentals of Electrotechnics and Electronics" in the Degree in Industrial Electronics Engineering. The subject is focused on the study and use of the principles of circuits' theory, and an introduction to electrical machines.
This is a fundamental subject inside the degree. The main objectives of the course are, on the one hand, to endow students with basic knowledge of electricity and electrical circuit analysis (the so-called circuits theory), and on the other hand, to introduce industrial applications of the basic electrical systems. The goal is ambitious and the contents are developed without going into great detail, but without abandoning the rigour required for this important matter. This subject introduces electronic circuits, introduces the fundamentals of circuits' theory for its analysis, and introduces the principles of electrical machines, both static and rotating. The final goal is that students understand the basic rationale under electronic circuits and how can they apply different techniques to solve any circuit. The course contents are:

- Unit 1: Circuit and systems. Elemental analysis of circuits. Transient and stationary. Free and forced response. Sinusoidal AC circuits. Transfer functions and frequency response. Laplace Transform for network analysis.
- Unit 2: Electrical machines. The basics of electromagnetism. General principles of electrical machines. Definition, classification and composition of electrical machines. Static and rotating machines.

The main objective of this course is to acquaint students with depth and detail on the basic fundamentals for the rest of their training as engineers in industrial electronics: linear circuit analysis and the basics of electronics. At the end of the course, students should be able to handle with ease the various mathematical tools taught during the course, and be able to solve electrical circuits using different approaches. They should be able to discern which approach is best from everyone they know to solve a particular circuit and semiconductor elements, which should be selected given the design specifications of the circuit to be implemented. In particular, the objectives pursued are:

- Know the basic concepts of voltage and current sources, and passive devices, and the basics of circuits theory.
- Ability to characterize both AC and DC circuits.
- Understand the concepts of phasor and impedance.
- Mastering the different algebraic forms of representation of phasors, including equivalence and correspondence with the sine functions in the time domain.
- Assimilation of Kirchhoff's laws in the complex domain.
- Understand the concepts of power, energy and its application in network theory.
- Acquire and remember the principles of network analysis of passive circuits, and the main theorems of analysis of them.
- Learn and remember the basic laws of electrical circuits, and know how to apply for solving troubleshooting using the easiest or more appropriate way in each case.
- Knowing the structural characteristics and performances of electrical machines.
- Knowledge of the functions of the magnetic circuit and use it as a link between the theory of electrical circuits and electrical machines.
- Assimilate the general principles of electrical machines, as to study static (transformer) and dynamic (synchronous machines, asynchronous and DC) electrical machines.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

There are not previous requirements of Electronics or Theory of Circuits, although it is desirable that the student is fluent in some physical concepts and the use of some basic mathematical tools, such as complex variable, vector calculus, differential and integral calculus, basic trigonometric and linear algebra, and logarithmic calculation.

OUTCOMES

1404 - Degree in Industrial Electronic Engineering

- CG3 - Knowledge of basic and technological subjects that allows students to learn new methods and theories and provides them with versatility to adapt to new situations.
- CG4 - Ability to solve problems with initiative, decision-making skills, creativity and critical reasoning and to communicate and transmit knowledge, abilities and skills in the field of industrial engineering (with specific industrial electronics technology).
- CG5 - Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and analogous work.
- CG6 - Ability to deal with specifications, regulations and mandatory standards.
- CG21 - Knowledge and use of the fundamentals of circuit theory and electric machines.
- CG22 - Knowledge of the fundamentals of electronics.

LEARNING OUTCOMES

This subject allows for the following learning outcomes:

1. Calculate the various electrical quantities of a circuit in steady state (G3, G4, G5, G22).
2. Know and apply the theorems and analysis techniques of linear circuits and alternating current (G3, G4, G5, G22).
3. Apply mathematical procedures and physical analysis of transients in first and second order circuits (G3, G4, G5, G22).
4. Knowing the basic components of electrical machines, as well as the different types of machines, their operating principles and main applications (G3, G5, G21, G22).
5. Identify and describe the basic ways of work of electronic devices (G3, G6, G22).

To complement the above results, this subject also fosters the student to acquire the following skills:

- Know the basic concepts of voltage and current sources, passive devices, basic points of circuits theory, characterize them, both continuous and in AC, and the concepts of phasor and impedance. He/she should also be familiar with the concepts of power and energy and its application in network theory.
- Acquire and remember the principles of network analysis of passive circuits, and the main theorems of analysis, learn and remember the basic laws of electrical circuits, to apply them to solve them using the most appropriate.
- Acquire the terminology used in the field of electronics.
- Learn to manage computer simulation programs for electronics and apply them in the field of circuit analysis.
- Know and master the most common mathematical transformations for circuit analysis.
- Correctly express the quantities that are measured in electrical circuits using proper units.
- Know the normalization method and be able to apply it to circuits for ease of numerical resolution.

- Understand the current-voltage relationships in the passive components (R, L, C) with different meanings in tension and intensity.
- Understand and apply basic circuit laws (Ohm, Joule, Kirchhoff).
- Know the different types of generators and the equivalence between them.
- Calculate the power consumption of basic passive circuit elements.
- Recognize the topology of a circuit and determine the minimum number of equations needed to analyze it.
- Apply methods for analyzing a circuit voltages and currents.
- Know and apply the fundamental theorems of circuit analysis: superposition, multiplication by a constant, Thevenin and Norton.
- Understand, represent and operate with sinusoidal functions.
- Analyze sinusoidal steady-state circuits, phasors and impedances.
- Calculate powers in sinusoidal steady state.
- Learning to make approximate Bode diagrams, both in magnitude and phase.
- Know and use the Laplace transform for circuit analysis.
- Mount and be able to perform actions on simple circuits.
- Know the basic components of electrical machines, as well as different types of machines, their operating principles and main applications.

DESCRIPTION OF CONTENTS

1. Electrical Circuits

1. Invariant linear circuit design in localized parameters. Voltage and current. Ohm's Law. Impedances. Basic elements: resistor, capacitor and inductance. Association of elements: series and parallel circuits. Voltage and current generators. Waveforms: properties.

2. Kirchhoff's laws. Concept of knots, branch and mesh. Laws of knots and meshes.

3. Energy and Power in an electrical network. Concept and units. Passive and active elements. Energy balance in a grid. Examples.

4. Theorem networks: overlay, Thevenin and Norton. Examples. Maximum power transfer.

5. Analysis of circuits with differential equations. Causal systems. Free and forced response. Transient and stationary states/regimes. Step and natural responses of linear RL, RC and RLC circuits.

6. Sinusoidal steady state. Fundamentals. Phasors. Complex electrical quantities. Alternating current.

7. Power and energy in the sinusoidal steady state: Active, reactive, apparent and complex. Power triangle. Boucherot Theorem. Power Factor.

8. Transfer function and frequency response. Representation on logarithmic scales. Decibels. Bode: definition and purpose. Zeros and real poles. Zeros and complex poles. Resonances. Damping. Examples.

9. The Laplace Transform in the analysis of networks. Definition, properties and utility. Basic impedance. Node analysis. Inverse transform.

2. Electrical machines

1. Power system: high, medium and low voltage. Generation and transmission. Definition and classification of electrical machines. Composition and basic elements of electrical machines. Magnetic fields, magnetic flux and electromotive force. Fundamental laws of magnetic circuits. Relations between electric and magnetic circuits.

2. Static electric machines, transformers. Parts of a transformer. Ideal transformer. Real transformer. Equivalent circuit of a transformer.

3. Introduction to electrical rotating machines motors and generators.

3. Laboratory Practice

1. Direct Current measurements: voltage and current. Ohm's Law. Multimeters. Resistance measurements. Voltage divider. Impedances Association. Power.

2. Analysis of circuits with differential equations.

3. AC measurements. Oscilloscope and signal generators.

4. TheTransformer and the linear regulated source.

5. Frequency Response and Bode diagrams

6. Analysis of circuits with the Laplace transform.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Classroom practices	10,00	100
Development of group work	10,00	0
Development of individual work	10,00	0
Preparation of evaluation activities	30,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	25,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the course is structured in four learning modalities: theory and problem solving sessions, individual tutoring, and presentation of technical documentation accounting for the laboratory practices.

Learning in group with the professor.
The theory and problem sessions will use the model of master lesson. In the theoretical sessions the professor will explain the fundamental contents of the subject using audiovisual aids, such as presentations and blackboard. In the problem sessions, the lecturer will explain a series of problems-type, thanks to which the student will learn how to identify the essential problem elements and the best solution for each problem. These sessions will encourage the participation between students and students/professor (G3, G4, G5, G6, G21, G22).
Tutoring.
The students will have tutoring sessions whose purpose is solve problems, doubts, orientation in works, etc. The tutoring schedule will be indicated at the beginning of the academic course. Additionally, some punctual doubts would be clarified by email.
Working in groups in the classroom.
In the laboratory, the groups will be formed by a maximum of two students, which have to organise to make the design, mount the electronic components and perform the experimental tests. Each practice has a estimated length of 3 hours.
Available educational resources.
The student will have from the start of the academic course the following documents:

- **Educational Guide**, which offers the sufficient informative elements to determine the subject contents, structure and evaluation methodology
- **Theoretical material** of each one of the lessons
- **Problem sets**.
- **Guide notes for the laboratory sessions**.

EVALUATION

Learning assessment follows the recommendations of the ETSE-AC2PI model, and is structured in the ongoing assessment of student achievements on a weighted basis of three parts:

Participation (10%, G3, G4). Attendance and class participation will be evaluated by the exercises done by the student, and group discussion of theoretical or practical aspects of the subject. The note of this section will weigh 10% in the final grade.

Laboratory (30%, G4, G5, G6, G22). The mark of the laboratory results will be obtained evaluating each lab session and with a final exam in the laboratory. It will be of the same nature as the lab sessions and will be held in the laboratory sessions in the final session. The evaluation of lab sessions (preparation 30%, development 70%) represents 40% of the lab mark, whereas the final lab exam constitutes the remaining 60%.

The lab mark obtained as described above will represent 30% of the grade of subject, and will be essential to obtain a 4 out of 10 for averaging it with the other parts of the assessment.

For students who do not pass this lab assessment will be two more calls on the dates and times officially designated by the center for the official examination of the subject, after the theory exam. The mark of this exam will represent 100% of mark lab, and 30% of the grade, and again will be essential to obtain a 4 out of 10 for averaging it with the other parts of the assessment.

Final exam (60%, G3, G4, G21, G22). The final exam will be done individually, will be written and based on problems to assess the degree of skill acquisition proposals. The theory grade will represent 60% of the grade of the subject.

A mark below 4 in any of these evaluations imply failing the subject.

In any case, the evaluation system will be guided by the University of Valencia Evaluation and Qualification Regulation for Grades and Masters (https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?idEdictoSeleccionado=5639).

REFERENCES

Basic

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- Irwin, J. D. Análisis básico de circuitos en ingeniería. Prentice-Hall, 1997.
- Soria, E.; Martín, J. D. y Gómez. L. Teoría de circuitos. McGraw-Hill (Serie Schaum), 2004.
- Espí, J.; Muñoz-Marí, J; Camps-Valls, G. Análisis de circuitos. PUV, 2006.
- José EspíLópez, Gustavo Camps Valls, Jordi Muñoz Marí, Electrónica analógica. Problemas y Cuestiones, Pearson Educación 2006.
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