Universidad de Alcalá

# TEACHING GUIDE

# Circuit Analysis

## Degree in
## Computer Engineering (GIC)

## Universidad de Alcalá

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## Academic Year 2025/2026

2nd Year - 2nd Semester (GIC)

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

# TEACHING GUIDE

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|---|---|
| Course Name: | **Circuit Analysis** |
| Code: | **590003 (GIC)** |
| Degree in: | **Computer Engineering (GIC)** |
| Department and area: | **Teoría de la Señal y Comunicaciones**<br>**Signal Theory and Communications** |
| Type: | **Compulsory (GIC)** |
| ECTS Credits: | **6.0** |
| Year and semester: | **2nd Year - 2nd Semester (GIC)** |
| Teachers: | To be defined. |
| Tutoring schedule: | To be confirmed at the beginning of the course. |
| Language: | English |

# 1. COURSE SUMMARY

The current society demands the use of new Information and Communications Technologies (ICT). These technologies involve a series of electronic equipment and devices such as mobile phones, satellites or antennas. The design, optimization and maintenance of these equipment's requires the knowledge of electrical systems and circuit analysis.

### Requirements and recommendations:

In the course of Circuit Analysis complex mathematical concepts will be used. It is recommended that the students have some ability in solving mathematical problems, and, more specifically, using complex numbers and trigonometry, solving systems of linear equations, decomposition in simple fractions and using exponential functions.

# 2. SKILLS

### Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following basic, generic and cross curricular skills:

**en_CG8** - Knowledge of the basic subjects and technologies, which enable them to learn and develop new methods and technologies, as well as those that provide them with great versatility to adapt to new situations.

**en_CG9** - Ability to solve problems with initiative, decision making, autonomy and creativity. Ability to know how to communicate and transmit the knowledge, skills and abilities of the profession of Computer Engineering Engineer.

**en_CB1** - That students have demonstrated to possess and understand knowledge in an area of study that is based on general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

**en_CB2** - That the students know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

**en_CB3** - That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

**en_CB4** - That students can transmit information, ideas, problems and solutions to both a specialized and non-specialized public.

**en_CB5** - That the students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

**en_TRU1** - Capacity of analysis and synthesis.

**en_TRU2** - Oral and written competencies.

**en_TRU3** - Ability to manage information.

**en_TRU4** - Autonomous learning skills.

**en_TRU5** - Team work.

### Specific Skills

This course contributes to acquire the following specific skills:

**en_CIC1** - Ability to design and build digital systems, including computers, microprocessor-based systems and communications systems.

**en_CIC5** - Ability to analyze, evaluate and select the most suitable hardware and software platforms for the support of embedded and real-time applications.

### Learning Outcomes

After succeeding in this subject the students will be able to:

**RA1**. Identify the key elements used to build electrical circuits, including their functionality and symbology.

**RA2**. Recognize the physical phenomena that occur in linear electrical circuits, particularly in sinusoidal steady state.

**RA3**. Apply the fundamental theorems of circuit theory to the analysis of any linear circuit in sinusoidal steady state.

**RA4**. Assemble prototypes of electric circuits and use the basic equipment's of any electrical circuit laboratory.

## 3. CONTENTS

| Contents Blocks | Total hours in classroom |
|---|---|
| **Module 1.** Basic concepts. Circuits fundamental laws. | 5 |
| **Module 2:** Analysis of DC steady-state circuits | 9 |
| **Module 3.** Sinusoidal Steady State circuit analysis. | 12 |
| **Module 4.** Systematic circuit analysis: mesh current analysis, analysis by node voltages | 6 |
| **Module 5.** Fundamental theorems: Linearity, Thevenin and Norton | 8 |
| **Module 6.** Two-port Networks analisys. | 6 |
| **Lab practices.** Passive components, power source, function generator, multimeter and oscilloscope. Circuit assembly and measurements in direct current and sinusoidal alternating current circuits. | 10 |

# 4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

## 4.1. Credits Distribution

| | |
|---|---|
| Number of on-site hours: | 60 hours (56 hours on-site + 4 exams hours) |
| Number of hours of student work: | 90 |
| Total hours | 150 |

## 4.2. Methodological strategies, teaching materials and resources

The teaching strategy of the course is divided into 3 sections: classroom learning, learning in small groups and finally the working sessions in the laboratory.

**Sessions of large group in the classroom:**

Working sessions in the classroom, in large groups, will consist of lectures where the main concepts of the theory of circuits will be presented.
The aim is to introduce students to the theoretical foundations of circuit analysis in a guided and reflective way. The understanding of these concepts will be enhanced in the small learning group with a more individualized assistance, by promoting both autonomous and grouped resolution of practical exercises and, also, with real experimentation in the lab. Teaching materials will be essential to create reflective learning environments, where students and teachers can undertake a critical analysis that allows the student to autonomously relate concepts.

The order of presentation of the contents will evolve from the simple to the complex, in order to avoid a high degree of abstraction that might cause a student lack of interest in the course. In any case, it is very convenient, during the working sessions in the classroom, to establish linkages with other subjects in the curriculum, and to provide possible experience on the contents, which will help to attract students' attention and will encourage their interest in the subject.

**Sessions of small groups:**

In the small groups of problems, our aim is to create participatory working environments. The students will solve theoretical problems with their peers, putting into practice the concepts covered during training sessions in the classroom. Student participation is essential, so we will use strategies to promote it (e.g. rounds of questions, debates, etc.). Our aim is to complete the teaching-learning process of the student, bringing he to the assimilation of concepts and their applications. We will emphasize that the analytical techniques must be considered as tools, not as goals. The strategies to adopt in these sessions are intended to promote the student habits when faced with solving a problem, namely: initial study of the circuit, choosing the best strategy for solving and critical evaluation of the results.

Information and Communications Technologies can also be used for supporting some of the training activities (Internet, forums, wikis and email, available materials in e-learning platforms, etc.).

**Laboratory sessions:**

Laboratory sessions comprise the third and final learning stage. The working sessions will be conducted

in small groups, in which the student must work with her peers. The goal is that the student explores, with the help of a practical manual designed for the course, the applicability of the concepts of circuit theory. To this end, the methodology will be as follows.

- Before each of the laboratory sessions, the student must work on the practice by performing theoretical calculations and even relying on simulation software for theoretical calculations and even using simulation software to obtain results that will later be checked in the laboratory.
  simulation software to obtain results that will later be verified in the laboratory. In this way, the student must know in depth what to do in each practice and in the laboratory he/she will be able to verify the difference between theoretical values the difference between theoretical values calculated and those obtained by means of real measurements in the laboratory. The simulation software will serve as a support for the realization of the experimental practice in the laboratory.
  the experimental practice in the laboratory.

- Within the laboratory, students will carry out the corresponding practice in groups of 2 or 3 people and at the end of the and at the end they will hand in the results of the work done.

# 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.

**Ordinary Call**

Continous Assessment:

Given the importance of this course in most of the subjects of subsequent courses in the degree of electrical engineering, the assessment should not only ensure that the student has obtained the main concepts of circuit theory, but that he has reached sufficient skills to be able to extrapolate that knowledge to the problems that students will find in the subjects mentioned.

Thus, it will be necessary to emphasize the educational nature of the continuous assessment described here. Since the main skills pursued by this course are related to the ability to analyze and solve problems by applying the theoretical concepts studied, the assessment will use instruments based on objective test of different types: problem solving and written tests focused on theoretic arguments.

According to this line, the main assessment tools will be:

1. Laboratory deliverables (ELx). Performance of some laboratory practices, results and answer to

their questions. The evaluation will consider the systematic observation, where the teacher will record the main difficulties and skills observed in each student, and the completion of a quiz for each practice.
2. Laboratory exam (PL). It consists of the assembly of an electrical circuit and the realization of different measurements in this circuit.
3. Evaluation Exams (PEx) Performance of face-to-face written tests focused on both practical and theoretical aspects of the subject consisting of the resolution of problems of application of the contents of the course. An Intermediate Evaluation exam (PEI) approximately halfway through the term and a Final Evaluation Exam (PEF) at the end of the course.

Students must attend 100% of the laboratory sessions and deliver the corresponding reports to all laboratory practices. Recovery sessions will be enabled for those students who have not attended any of the sessions and justify it documentarily.

**Assessment through final exam:**

In the case of those students who must be evaluated by means of the final evaluation system, the evaluation elements to be used will be the following:

1. Laboratory deliverables (EL). Report with contents of the laboratory practices.
2. Laboratory exam (PL). It consists of the assembly of an electrical circuit and realization of different measurements in this circuit.
3. Final on-site exam (PEF). A written test focused on the practical and theoretical aspects of the whole subject consisting in the resolution of problems of the application of the contents of the whole course.

### Extraordinary Call

The procedure will be the same as the one described for the evaluation by final evaluation, with the difference that since the student must have done the laboratory practices, he/she will only have to take the laboratory test (PL) for the laboratory part. Those students who have successfully passed the laboratory part (passing 50% of the total laboratory grade) in the previous convocatory can keep the grade obtained for this exam session and only take the Final Evaluation Test (PEF).

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.

## 5.2. EVALUATION

### EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined::

**CE1.** The student is able to analyze and understand the operation of any linear circuit, regardless of the nature and complexity of it.

**CE2.** The student understands and is able to handle the equipment of a laboratory electrical measurement.

**CE3.** The student acquires skills to search for information and to coordinate with other partners to solve the proposed activities in small group sessions, in the laboratory, or when working outside the classroom.

**CE4.** The student is able to express the resolution of a problem in a clear way, orderly, and always following the correct nomenclature and formulation.

## GRADING TOOLS

This section describes the grading tools that will be applied to each of the evaluation criteria.

- **Deliverable or laboratory Quizzes (ELx):** Some deliverable or quizzes referring to the results and conclusions of the 3 laboratory practices (one quiz per practice).
- **Laboratory Exam (PL):** It consists of the assembly of an electrical circuit and the realization of different measurements in this circuit.
- **Intermediate Evaluation Exam (PEI):** Written on-site exam focused on the practical and theoretical aspects of the subject. Consisting in the solving of some exercises of application of the contents of the course.
- **Final Evaluation Exam (PEF):** A single face-to-face test with the same characteristics as the PEI. It is necessary to differentiate this test for the ordinary call will be the theoretical-practical written exam carried out at the end of the term that, although all the knowledge of the subject is required, it will focus on the topics not evaluated in the PEI. In the case of the extraordinary call and final evaluation, this test will evaluate all the topics seen in the whole course.

## GRADING CRITERIA

In the ordinary call-continuous assessment the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows:

| Skill | Learning Outcomes | Evaluation Criteria | Grading tool | Contribution to the final mark |
|---|---|---|---|---|
| CG8, CG9, CB1, CB2, CB3, TRU1, TRU2, TRU3, TRU4 | RA1, RA2 | CE1, CE4 | PEI | 30% |
| CG8, CG9, CB1, CB2, CB3, CB4, CB5, TRU1, TRU2, TRU3, TRU4 | RA2, RA3 | CE1, CE4 | PEF | 40% |
| CG8, CG9, CB1, CB2, CB3, CB4, CB5, CIC1, TRU1, TRU2, TRU5 | RA1, RA4 | CE2 | PL | 20% |
| CG8, CG9, CB1, CB2, CB3, CB4, CB5, CIC1, CIC5, TRU1, TRU2, TRU3, TRU4, TRU5 | RA1, RA2 | CE3 | EL | 10% |

The grade of “Not presented‘’ will be given to the student who, having opted for the continuous evaluation procedure, does not attend the Final Evaluation Test (PEF).

In this exam session, if you have obtained at least 50% of the laboratory grade (PL and EL), you will be able to keep this laboratory grade and only take the theoretical-practical part (PEF) of the exam in the extraordinary call.

Ordinary Final-Evaluation call

In the case of the ordinary call by means of final evaluation, the relation between the competences, learning results, evaluation criteria and instruments, is the following.

| Skill | Learning Outcomes | Evaluation Criteria | Grading tool | Contribution to the final mark |
|---|---|---|---|---|
| CG8, CG9, CB1, CB2, CB3, CB4, CB5, CIC1, CIC5, TRU1, TRU2, TRU3, TRU4, TRU5 | RA1, RA2, RA4 | CE2, CE3 | PL (20%), EL (10%) | 30% |
| CG8, CG9, CB1, CB2, CB3, CB4, CB5, TRU1, TRU2, TRU3, TRU4 | RA2, RA3 | CE1, CE4 | PEF | 70% |

The grade of "Not presented" will be given to the student who, having opted for the continuous evaluation procedure, does not attend the Final Evaluation Test (PEF).

In this exam session, if you have obtained at least 50% of the laboratory grade, you will be able to keep this laboratory grade and take only the PEF in this convocatory.

In the **extraordinary call**, the relationship between the competences, learning results, criteria and evaluation instruments is as follows,

| Skill | Learning Outcomes | Evaluation Criteria | Grading tool | Contribution to the final mark |
|---|---|---|---|---|
| CG8, CG9, CB1, CB2, CB3, CB4, CB5, CIC1, CIC5, TRU1, TRU2, TRU3, TRU4, TRU5 | RA1, RA2, RA4 | CE2, CE3 | PL (20%), EL (10%) | 30% |
| CG8, CG9, CB1, CB2, CB3, CB4, CB5, TRU1, TRU2, TRU3, TRU4 | RA2, RA3 | CE1, CE4 | PEF | 70% |

The grade of "Not presented" will be given to the student who, having opted for the continuous evaluation procedure, does not attend the Final Evaluation Test (PEF).

It is a requirement for passing the course, in any of the calls, the passing of :

- The competences corresponding to the laboratory (which supposes the obtaining of 5 points out of 10 points of the laboratory grade), by means of the laboratory practices (PL) together with the deliverables (EL). If the laboratory part is not passed and the total grade (theory plus laboratory) exceeds 5 points, the student will be graded with a grade of 4.5 points.

# 6. BIBLIOGRAPHY

## 6.1. Basic Bibliography


- Desoer C.A. and Kuh, E.S., Basic Circuit Theory, McGraw-Hill, 1966.


## 6.2. Additional Bibliography


- Van Valkenburg, M. E., Network Analysis - 3rd Edition. Prentice-Hall, 1974.
- Balabanian, N., Fundamentals of circuit theory, Allyn & Bacon, 1961.

## 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.