Universidad de Alcalá

# TEACHING GUIDE

# Circuit Analysis

## Degree in
## Industrial Electronics and Automatics Engineering

## Universidad de Alcalá

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## Academic Year 2024/2025

1st Year - 2nd Semester

Approved by the EPS School Board on June 14th, 2024

# TEACHING GUIDE

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|---|---|
| Course Name: | **Circuit Analysis** |
| Code: | **600026** |
| Degree in: | **Industrial Electronics and Automatics Engineering** |
| Department and area: | **Teoría de la Señal y Comunicaciones**<br>**Electrical Engineering** |
| Type: | **Compulsory** |
| ECTS Credits: | **6.0** |
| Year and semester: | **1st Year, 2nd Semester** |
| Teachers: | José María Muñoz Ferreras |
| Tutoring schedule: | Consultar al comienzo de la asignatura |
| Language: | English |

# 1. COURSE SUMMARY

The subject “Circuit Analysis” is a mandatory course that is common to all industrial engineering-related studies especially for the “Ingeniería en Electrónica y Automática Industrial” degree. Within the aforementioned studies, this subject is scheduled to be taught during the second semester of the first course.

The aim of this course is to introduce the student to the basic physical foundations and analysis techniques of electrical circuits. The fundamental concepts covered by this course are considered essential for a proper understanding of higher-level subjects to be studied in subsequent years within the areas of electrical, electronic, and automatic engineering.

It is the key purpose of this course to facilitate a deeper understanding of main concepts involved on electrical circuits, as well as to provide the students with the necessary tools and skills to successfully analyze and solve related problems both by applying systematic methodologies and by proposing and discussing alternative (i.e., non-systematic) approaches. This course is complemented with a number of laboratory (i.e., practical-oriented) sessions enabling the students to reinforce the fundamental concepts that are acquired during the theoretical sessions.

Note also that despite this course is situated within the first year of the studies, it has a strong practical character so that most of the concepts are supported through real system application examples.

# 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/351/2009:

**en_TR2** - Knowledge in basic and technological subjects, which enables them to learn new methods and theories, and gives them versatility to adapt to new situations.

**en_TR3** - Ability to solve problems with initiative, decision making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.

**en_TR4** - Knowledge to carry out measurements, calculations, assessments, appraisals, appraisals, studies, reports, work plans and other similar works.

**en_TR9** - Ability to work in a multilingual and multidisciplinary environment.

**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.

### 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/351/2009:

**en_CI4** - Knowledge and use of the principles of circuit theory and electrical machines.

### Learning Outcomes

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

**RA1**. Formulate the voltage-current response of passive (i.e., resistors, inductors, and capacitors) and active elements in electrical circuits.

**RA2**. Explain the concepts of alternate current and analysis of related circuits in sinusoidal steady-state regime in the complex domain (phasors).

**RA3**. Apply linearity theorems for electrical circuits: Thevenin, Norton, and maximum power transfer theorems.

**RA4**. Analyze three-phase systems.

**RA5.** Analyze circuits in transient regime, by means of solving differential equations and the Laplace transform.

**RA6**. Learn the use of basic instrumentation and equipment for the measurement of currents and voltages in electrical circuits.

# 3. CONTENTS

| Contents Blocks | Total number of theory hours |
|---|---|
| **Module 1.** Foundations of electrical circuits. Time behavior of lumped elements. Current and voltage generators. Direct current (DC) circuits. | 14 hours (8 theory, 6 practice) |
| **Module 2**. Alternate current (AC) circuits in sinusoidal steady-state regime and their analysis. Generators and passive components. Basic circuit-analysis theorems. | 20 hours (10 theory, 10 practice) |
| **Module 3**. Three-phase systems. Analysis of balanced and unbalanced systems. Power in three-phase systems. | 12 hours (6 theory, 6 practice) |
| **Module 4.** Circuits in transient regime, time behaviour and solving in the Laplace domain. | 12 hours (6 theory, 6 practice) |

# 4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

## 4.1. Credits Distribution

| | |
|---|---|
| Number of on-site hours: | 58 hours (56 hours on-site +2 exams hours) |
| Number of hours of student work: | 92 |
| Total hours | 150 |

## 4.2. Methodological strategies, teaching materials and resources

**Sessions of theoretical content:**

Methodology: Lecture sessions in large groups (50 students per group) where the teacher expounds the most important theoretical concepts and complement them by means of practical applications and real examples. Students are encouraged to participate in an interactive environment both for the discussion of theoretical contents and the solving process of real-application cases. In these lectures, the blackboard, slides, supporting basic bibliography, and/or computer tools that facilitate the e-learning will be employed.

**Practical sessions of problem solving:**

Methodology: small groups (25 students per class) for individual and cooperative work focused on the solving of problems and practical examples related with the acquired theoretical contents. Oral and written exposition and discussion of common proposals and interpretation of results. In these sessions, the blackboard, slides, supporting basic bibliography, and/or computer tools that facilitate the e-learning will be employed.

**Practical laboratory sessions:**

Methodology: practical work in teams of no more than 3 students (within a full group of 25 students). After an introductory explanation and a general
discussion to clarify the purpose of each session, the students must perform and solve the proposed laboratory exercises under the guidance of the teacher. In these sessions, the blackboard, slides, and the instrumentation/equipment of the laboratory will be used.

**Office hours and seminaries:**

Personalized and collective assistance of the teacher about the theoretical and practical contents of the subject.

# 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**

Continuous Assessment:

It consists in the elaboration and passing of the laboratory sessions (during the course), active participation on on-site sessions, and successful realization of: i) theoretical questions and practical exercises proposed in on-site sessions, ii) two midterm exams, and iii) a final exam.

Those students that after selecting the “continuous-assessment” procedure show up only in the first partial-evaluation exam will be considered as “non-sited".

Assessment through final exam:

It will consist in the elaboration and passing of a final exam where the learning results of the student will be evaluated.

Independently of the evaluation system selected by the student, the attendance and overcoming of the laboratory part is mandatory in order to pass the subject. Laboratory sessions are evaluated attending to both the skills demonstrated for the correct use of the instrumentation/equipment and the technical quality of a final report prepared for each session. Note that the additional value that supposes the practical validation of the theoretical concepts of the subject is considered essential in a practical-oriented subject like "Circuit Analysis".

### Extraordinary Call

Those students failing in the ordinary call (either in the modality of continuous assessment or final assessment) are allowed to realize a final exam consisting in written-level theoretical-practical exercises.

## 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 understands the expounded theoretical concepts.

**CE2.** The student is able to analyze and solve exercises of electrical circuits, understanding of the underlying approach, correct use of available data,
proposal of alternatives, adequate solving and interpretation of the obtained results.

**CE3.** The student is capable of taking his own decisions and demonstrates good presentation skills both at the oral and written levels. He also shows positiveattitude for the participation on on-site theoretical and practical sessions in an integrated environment with the teacher and the other students.

**CE4.** The student understands the theoretical background of the laboratory sessions and correctly interprets the obtained results.

**CE5.** The student shows interest and good skills for the correct handling of the laboratory equipment/instrumentation during the practical sessions.

**CE6.** Evolution and quality of the work/effort of the student during the course.

### GRADING TOOLS

The following assessment tools will be adopted to evaluate the performance of the student during the course in relation to the proper acquisition of the expounded competencies:

- Monitoring of the attendance and positive participation in the theoretical and practical sessions (SAP). This mainly refers to the in-time delivering of solved exercises by the students that are realized during their study hours (and evaluated by the teacher), as well as correct replies to questions and solving of exercises to be done during the on-site sessions.
- Evaluation and monitoring of the student during the laboratory sessions (PL).
- Evaluation of the acquired knowledge in two partial exams (PEI).
- Final exam consisting of several theoretical-practical exercises in a given duration (PEF).

### 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 |
|---|---|---|---|---|
| TR2-4, TR9, TRU1-5, CI4 | RA1, RA2, RA3, RA4, RA5 | CE1, CE2, CE3, CE6 | SAP | 10% |
| TR2-4, TR9, TRU1-5, CI4 | RA1 | CE1, CE2, CE3 | PEI1 | 20% |
| TR2-4, TR9, TRU1-5, CI4 | RA2, RA3 | CE1, CE2, CE3, CE6 | PEI2 | 20% |
| TR2-4, TR9, TRU1-5, CI4 | RA1, RA2, RA3, RA4, RA5, RA6 | CE1, CE2, CE3, CE4, CE5, CE6 | PL | 10% |
| TR2-4, TR9, TRU1-5, CI4 | RA1, RA2, RA3, RA4, RA5 | CE1, CE2, CE3, CE6 | PEF | 40% |

In the ordinary call-final evaluation, 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 |
|---|---|---|---|---|
| TR2-4, TR9, TRU1-5, CI4 | RA1, RA2, RA3, RA4, RA5, RA6 | CE1, CE2, CE3, CE4, CE5, CE6 | PL | 10% |
| TR2-4, TR9, TRU1-5, CI4 | RA1, RA2, RA3, RA4, RA5 | CE1, CE2, CE3, CE6 | PEF | 90% |

Extraordinary call

Those students failing in the ordinary call (either in the modality of continuous assessment or final assessment) are allowed to realize a final exam consisting in written-level theoretical-practical exercises.

# 6. BIBLIOGRAPHY

## 6.1. Basic Bibliography

- López-Ferreras, F., Maldonado-Bascón, S., Rosa-Zurera, M., "Análisis de Circuitos Lineales", Editorial Rama.
- Gómez Expósito, A., Martinez Ramos JL., Rosendo Macías JA., Romero Ramos E., Riquelme Santos JM. "Fundamentos de Teoría de Circuitos". Thomson Editores Spain, Paraninfo SA, 2007.
- Valentín Parra Prieto, "Electrotecnia I y II". Ed. UNED.
- Enrique Ras: "Teoría de circuitos". Ed. Marcombo.
- Enrique Ras: "Redes eléctricas y multipolos". Ed. Marcombo.


## 6.2. Additional Bibliography

## 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.