Universidad de Alcalá

TEACHING GUIDE

Circuit Theory

Degree in
Telecommunication Technologies Engineering (GITT)
Telecommunication Systems Engineering (GIST)
Telematics Engineering (GIT)
Electronic Communications Engineering (GIEC)

Universidad de Alcalá

Academic Year 2026/2027

1st Year - 1st Semester (GITT+GIST+GIT+GIEC)

Approved by the EPS School Board on June 15th, 2026

TEACHING GUIDE

Course Name:	**Circuit Theory**
Code:	**350004 (GITT+GIST+GIT+GIEC)**
Degree in:	**Telecommunication Technologies Engineering (GITT)** **Telecommunication Systems Engineering (GIST)** **Telematics Engineering (GIT)** **Electronic Communications Engineering (GIEC)**
Department and area:	**Teoría de la Señal y Comunicaciones** **Signal Theory and Communications**
Type:	**Basic (GITT+GIST+GIT+GIEC)**
ECTS Credits:	**6.0**
Year and semester:	**1st Year - 1st Semester (GITT+GIST+GIT+GIEC)**
Teachers:	Roberto Javier López Sastre Philip Siegmann
Tutoring schedule:	To be published at the beginning of the term
Language:	English

1. COURSE SUMMARY

The current society demands the use of new information and communications technologies (ICT). These technologies require a series of electronic equipment and devices such as mobile phones, satellites or antennas. The design, optimization and maintenance of these equipments require expertise. One of the pillars of this expertise is the study of electrical phenomena and theorems of circuit analysis.

The tools and concepts discussed in this course are the bases of all the subjects that need an understanding of the basics of electricity and electronics. Some of them will be the following subjects: Analysis of Digital Circuits and Electronics in the second semester, Signals and Systems, Basic Electronics, Communication Theory, Circuits and Electronics, and Wave Propagation in the second year, or all those other subjects that study wireless, microwave or cable based telecommunication systems.

Prerequisites and recommendations:

In the course of Circuit Theory, 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 logarithmic and exponential functions.

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/352/2009:

en_TR2 - Knowledge of basic subjects and technologies that enables to learn new methods and technologies, as well as to provide versatility that allows adaptation to new situations.

en_TRU2 - Oral and written competencies.

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/352/2009:

en_CB4 - Understanding of: the basic concepts about linear systems and their associated functions and transform domains, theory of electrical circuits, electronic circuits, semiconductor physical principles, electronic and photonic devices, materials technology and its applications to solve engineering problems.

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, specially 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 equipments of any electronic circuits laboratory

3. CONTENTS

Contents Modules	Total number of hours
Module 1. Introduction to circuit thery. Basic concepts. Power and Energy of dipoles. Voltage current relation in generators and passive elements. Magnetic coupling. Electric circuit. Kirchhoff laws.	• 6 hours
Module 2. Direct Current (DC) Circuit Analysis. Behavior of the circuital elements in DC. Circuit analysis using Kirchhoff laws; mesh and nodal analysis methods.	• 6+8 hours
Module 3. Fundamental theorems. Equivalent circuits. Thevenin and Norton theorems. Linearity properties. Reciprocity theorem.	• 5+5 hours
Module 4. Alternating Current (AC) Circuit Analysis. Sinusoidal Steady State circuit analysis. Generalization of the theorems.	• 10+10 hours

Laboratory Content Modules	Number of sessions (hours)
Module 1. Measurements of DC circuits	1 session (2 hours)
Module 2. Measurements of AC circuits	1 sessions (2 hours)
Module 3. Phase shifting measurements im AC circuits and measurements of equivalent impedances using the oscilloscope	1 sessions (2 hours)

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

The teaching strategy of the course is divided into 3 blocks: 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 objective is to introduce students to the theoretical foundations of circuit analysis in a guided and reflective way. The understanding of these concepts will culminate with the use of them in both the laboratory and the problem-solving sessions in small groups. Teaching materials will be essential to create reflective learning environments, where students and teachers can undertake a critical analysis that allows the student to relate concepts in an autonomus way.

On one hand, to reduce abstraction and facilitate the understanding of the fundamental theorems, the contents will evolve from a simple point of view (DC analysis) to the more general and complex circuits behavior (AC analysis). On the other hand, in order to attract students' attention and encourage their interest in the subject, it is very convenient, during the working sessions in the classroom, to show how the new concepts will be related to other subjects which are or will be seen in the next semesters.

Sessions of small groups:

Small problem groups are intended to create participatory work 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.). The objective is to complement the teaching-learning process of the student, bringing him/her closer to the assimilation of the concepts and their application, emphasizing that the analytical techniques to be used are tools and not objectives. The strategies to be adopted in these sessions will be aimed at fostering in the student certain habits when facing the resolution of a problem, namely: initial study of the problem, choice of the best analytical strategy and critical evaluation of the results obtained.

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

Laboratory sessions:

Laboratory sessions is the third and final learning stage. The lab sessions will be conducted in small groups, in which the student must work with their 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 lab session, each individual student must perform and deliver a virtual practice to be delivered through the virtual classroom. The virtual practice consist on a simulation, by means of the corresponding software, of the real lab practice, that will be performed later in peers. In this way, the real results will be previously simulated so that it can be and compared and appreciate their differences.

Within the laboratory, students will perform the corresponding practice in groups of two people, and at the end they will deliver to the teacher a report of the work and measurements performed. In the last session, students will perform a final test, individually, where they will demonstrate the skills acquired.

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:

Given the importance of this course in most of the subjects of subsequent courses in the degree of telecommunications, the assessment should not only ensure that the student has asimilated 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 posterior 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 that have been studied, the assessment will use instruments based on objective test of different types: problem solving, and written tests focused on theoretical arguments.

In the small groups, it will be necessary to distinguish between the classes devoted to the laboratory, and those dedicated to solving problems.

Evaluation of the lab practices

In the laboratory, some of the pursued skills are different from those pursued in the large groups, so the evaluation and the grading criteria for this part will be different.

In this case, and given that the main competence pursued in this block of the course is to acquire the capacity and ability to handle the instruments of a laboratory, the evaluation will be based on the performance of a final practical test in the laboratory itself.

Also, given that the laboratory methodology is based on the realization of several practices at the assigned days, it will be necessary, for the proper monitoring of the continuous assessment, the delivery of a report or memory after every practice.

Final evaluation

For those students who do not opt for continuous evaluation, as stated in the regulations of the evaluation of the learning processes, the evaluation will consist of the following tests and activities:

- Completion of a final test, which will consist of solving a series of problems in a given time
- Completion of the laboratory practices, as well as a final test in the laboratory

Extraordinary call

The extraordinary call will consist of performing a single final exam consisting in solving a number of problems in a given time. Whatever the outcome of this exam, students will also have to do the lab practices as well as the lab examination. The students that have not passed the laboratory during the ordinary call, as is described in the section a) “Continuous assessment”, will not have to repeat the lab test.

In any case, the partial results, that the student may have obtained in the continuous assessment of the ordinary call, will not be taken into account. Only the results obtained in the laboratory part will be kept, if this part has been successfully passed.

5.2. EVALUATION

EVALUATION CRITERIA

After having taken the course, the student should have acquired the following knowledge and skills:

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 measurements.

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:

In this section we specify the grading tools to be applied to each of the evaluation criteria.

- Midterm Evaluation Test (PEI): The midterms will consist in solving problems where basic concepts are applied.
  - PEI-1 Resolution of several exercises and theoretical questions of DC circuits (Module 1 and 2)
  - PEI-2 Resolution of several exercises and theoretical questions of AC circuits (Module 3 and 4)
- Laboratory Test (PRL): Final test in the laboratory where the student will demonstrate the knowledge acquired.
- Final Evaluation Test (PEF): It consist in the resolution of problems in which all the concepts studied along the course will be applied

Grading Criteria

For each type of the evaluation calls , the relationship between the evaluation criteria, the tools and the grading is as follows.

Ordinary call, Continuous Assessment

Skill	Learning outcome	Evaluation criterion	Grading tool	Contribution to the final mark
TR2, TRU2, CB4	RA1	CE1, CE4	PEI-1	40%
TR2, TRU2, CB4	RA1, RA2, RA3, RA4	CE1, CE2, CE3, CE4	PRL	20%
TR2, TRU2, CB4	RA1, RA2, RA3	CE1, CE4	PEI-2	40%

The grade of “No presentado” will be applied to those students who do not show up for the PEI-2.

Ordinary call, Final Assessment

Skill	Learning outcome	Evaluation criterion	Grading tool	Contribution to the final mark
CB4	RA1, RA4	CE1, CE2, CE3, CE4	PRL	20%
TR2, TRU2, CB4	RA1, RA2, RA3	CE1, CE2, CE4	PEF	80%

The grade of “No presentado” will be applied to those students who do not show up for the Final Evaluation Test (PEF)

Extraordinary Call

Skill	Learning outcome	Evaluation criterion	Grading tool	Contribution to the final mark
CB4	RA1, RA4	CE1, CE2, CE3, CE4	PRL	20%
TR2, TRU2, CB4	RA1, RA2, RA3	CE1, CE2, CE4	PEF	80%

The grade of “No presentado” will be applied to those students who do not show up for the Final Evaluation Test.

For any of the possible assessment, to pass the course it is required to pass the laboratory. This means

to achieve a minimum of 50% of the corresponding PL grading (1 points).

The teaching-learning methodology and assessment process will be adapted as needed, in accordance with the guidance of the Delivery Support Unit, to implement curricular adaptions for students with specific needs.

6. BIBLIOGRAPHY

6.1. Main Bibliography

- W. Nilsson, S. A. Riedel. “Electric Circuits”. Pearson Prentice-Hall, 2005.

6.2. Complementary Bibliography

- Balabanian. “Electric Circuits”. McGraw-Hill, 1994.
- Van Valkenburg., Análisis de Redes. Editorial Limusa, 1982.
- Guillemin, E.A., Introducción a la Teoría de Circuitos. Editorial Reverté, 1959.
- Gómez Expósito, A. Fundamentos de teoría de circuitos. Thomson, 2007

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.