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 2021/2022

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

Approved by the School Board on July 6, 2021

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.	• 8 hours
Module 2. Direct Current (DC) Circuit Analysis. Behavior of the circuital elements in DC. Circuit analysis using Kirchhoff; mesh and nodal analysis methods.	• 10 hours
Module 3. Fundamental theorems. Equivalent circuits. Thevenin and Norton theorems. Linearity properties. Reciprocity theorem.	• 10 hours
Module 4. Alternating Current (AC) Circuit Analysis. Sinusoidal Steady State circuit analysis. Generalization of the theorems.	• 11 hours
Module 5. Magnetic coupling. Coupled coils, transformers and autotransformes.	• 7 hours

Laboratory Content Modules	Total number of hours
Module 1. Passive components, function generator and multimeter.	• 1 session (2 hours)
Module 2. Oscilloscope.	• 1 session (2 hours)
Module 3. DC measurements	• 1 session (2 hours)
Module 4. AC measurements	• 1 session (2 hours)
Module 5. Phase shifting measurements im AC circuits and measurements of equivalent impedances using the oscilloscope	• 1 session (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 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 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 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 .

May be used Information and Communications Technologies 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 sessions of the laboratory, the student must complete and deliver a virtual practice. This virtual practice will correspond to the simulation, using the corresponding software, of the practice that will be completed later in the laboratory.

In the lab, students will work in groups of 2 or 3 people. When the practice exercise finishes, the students must deliver to the teacher a report that collects the measures and work performed. In the last laboratory session of the course, the students will perform a final test, individually, in which 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 (Regulations for the Regulation

of Teaching Learning Processes, NRPEA, 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 Regulations for the Evaluation of Apprenticeships (approved by the Governing Council on March 24, 2011 and modified in the Board of Directors). Government of May 5, 2016) 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 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.

In the small groups, it will be necessary to distinguish between the classes devoted to the laboratory, and those dedicated to solving problems. 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 described later in this section of the document.

For small groups of solving problems, apart from the instruments mentioned above, other evidences will be used, such as:

- An analysis of the work of the students in not on-site hours.
- The observation of proactivity in resolving problems.
- Participation in the group.

Assessment of the exercises of the laboratory:

As mentioned above, the tools described in this section will be used in evaluating the specific laboratory skills.

Given that the main skill pursued in this block of the course is to acquire the capacity and ability to manage the laboratory instruments, the assessment will be based mainly on a systematic observation, both during the development of the practice sessions and the realization of the final test.

Also, given that the laboratory methodology is based on the realization of a daily practice, it will be necessary, for the proper monitoring of the continuous assessment, the delivery of a memory after every practice.

Final assessment:

For those students who do not opt for continuous assessment, as stated in the regulations governing the processes of learning assessment, the assessment will be to carry out the following tests and activities:

- Making a final test, consisting in solving a number of problems in a given time.
- Performing the lab sessions, and making a final test of the laboratory.

To qualify for the final evaluation, the student must apply in writing to the dean or director of the center in the first two weeks of teaching of the subject, explaining why he/she is refusing to follow the

continuous assessment system. For students who have no formalized its enrollment to the course due to justified grounds, the mentioned deadline starts since they join the degree. The dean or center director must assess the circumstances cited by the student and make a reasoned decision. After 15 days, if the student has not received any written response to his/her request, it is deemed to have been dismissed

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 test, students must successfully completed the lab practices as well as the lab test. 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 practices.

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, except if it refers to the laboratory.

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 (PEI): The midterms will consist in solving problems where basic concepts are applied.
    - PEI-1: Solving circuits in direct current. This test will be retakeable on the same date as that established for the completion of the Final Test (PEF).
- Practicals Assignments (PL): The students must elaborate a document to include all the results and conclusions obtained during the practical sessions in the laboratory. They will also have to complete a final test.
- Final Test (PEF): It is an exam where the student will solve different problems related with the contents of the course.

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 Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
TR2, CB4	RA1, RA2	CE1	PEI	30%
TRU2, CB4	RA1, RA4	CE2, CE3	PL	30%
TR2, TRU2, CB4	RA2, RA3	CE1, CE4	PEF	40%

Ordinary call, Final Assessment

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
CB4	RA1, RA4	CE2, CE3	PL	30%
TR2, TRU2, CB4	RA2, RA3	CE1, CE2, CE4	PEF	70%

Extraordinary Call

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB4	RA1, RA4	CE2, CE3	PL	30%
TR2, TRU2, CB4	RA2, RA3	CE1, CE2, CE4	PEF	70%

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% pf the corresponding PL grading (1,5 points).

6. BIBLIOGRAPHY

6.1. Basic Bibliography

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• W. H. Hayt, J. E. Kemmerly, S. M. Durbin. “Engineering Circuit Analysis”. McGraw-Hill, 2002.

6.2. Additional Bibliography

- N. Balabanian. “Electric Circuits”. McGraw-Hill, 1994.
- C. R. Paul. “Analysis of linear circuits”. McGraw-Hill, 1989.

- Van Valkenburg., Análisis de Redes. Editorial Limusa, 1982.
- Guillemin, E.A., Introducción a la Teoría de Circuitos. Editorial Reverté, 1959.
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- P. Gil Jiménez, R. Vicén Bueno, R. López Sastre, L. Álvarez Pérez, P. Siegmann: “Circuitos Eléctricos: Manual de Prácticas de Laboratorio”. Servicio de publicaciones de la Universidad de Alcalá.

Disclosure Note

The University of Alcalá guarantees to its students that, if due to health requirements the competent authorities do not allow the total or partial attendance of the teaching activities, the teaching plans will achieve their objectives through a teaching-learning and evaluation methodology in online format, which will return to the face-to-face mode as soon as these impediments cease.