30116 - Basic principles of electrical technology

Información del Plan Docente

Academic Year	2016/17
Academic center	175 - Escuela Universitaria Politécnica de La Almunia 179 - Centro Universitario de la Defensa - Zaragoza
Degree	425 - Bachelor's Degree in Industrial Organisational Engineering 563 - Bachelor's Degree in Industrial Organisational Engineering 457 - Bachelor's Degree in Industrial Organisational Engineering
ECTS	6.0
Course	2
Period	Second semester
Subject Type	Compulsory
Module	---

1.Basic info

1.1.Recommendations to take this course

1.2.Activities and key dates for the course

2.Initiation

2.1.Learning outcomes that define the subject

2.2.Introduction

3.Context and competences

3.1.Goals

3.2.Context and meaning of the subject in the degree

3.3.Competences

3.4.Importance of learning outcomes

4.Evaluation

5.Activities and resources

5.1.General methodological presentation

The learning process designed for this subject is based on the following:

SPECIALIZATION IN BUSINESS

30116 - Basic principles of electrical technology

Strong interaction between the teacher/student. This interaction is brought into being through a division of work and responsibilities between the students and the teacher. Nevertheless, it must be taken into account that, to a certain degree, students can set their learning pace based on their own needs and availability, following the guidelines set by the teacher.

The current subject fundamentals of Electrotechnics is conceived as a stand-alone combination of contents, yet organized into three fundamental and complementary forms, which are: the theoretical concepts of each teaching unit, the solving of problems or resolution of questions and laboratory work, at the same time supported by other activities.

The organization of teaching will be carried out using the following steps:

— **Theory Classes** : Theoretical activities carried out mainly through exposition by the teacher, where the theoretical supports of the subject are displayed, highlighting the fundamental, structuring them in topics and or sections, interrelating them.

— **Practical Classes** : The teacher resolves practical problems or cases for demonstrative purposes. This type of teaching complements the theory shown in the lectures with practical aspects.

— **Laboratory Workshop** : The lecture group is divided up into various groups, according to the number of registered students, but never with more than 20 students, in order to make up smaller sized groups.

— **Individual Tutorials** : Those carried out giving individual, personalized attention with a teacher from the department. Said tutorials may be in person or online.

Defence profile

Ongoing study and effort are essential to achieve the learning outcomes of this course.

The methodology is based on lectures, practical classes with student participation, laboratory sessions. Some individual graded assignments are issued throughout the semester, such as homework, quizzes and other activities, trying to encourage the continued work of students.

5.2.Learning activities

The programme offered to the student to help them achieve their target results is made up of the following activities...

30116 - Basic principles of electrical technology

SPECIALIZATION IN BUSINESS

Involves the active participation of the student, in a way that the results achieved in the learning process are developed, not taking away from those already set out, the activities are the following:

— **Face-to-face generic activities** :

● Theory Classes: The theoretical concepts of the subject are explained and illustrative examples are developed as support to the theory when necessary.

● Practical Classes: Problems and practical cases are carried out, complementary to the theoretical concepts studied.

● Laboratory Workshop: This work is tutored by a teacher, in groups of no more than 20 students.

— **Generic non-class activities** :

● Study and understanding of the theory taught in the lectures.

● Understanding and assimilation of the problems and practical cases solved in the practical classes.

● Preparation of seminars, solutions to proposed problems, etc.

● Preparation of laboratory workshops, preparation of summaries and reports.

● Preparation of the written tests for continuous assessment and final exams.

- Tutored autonomous activities.
Although they will have more of a face character have been taken into account in part for their idiosyncrasies, they will be primarily focused on seminars and tutorials under the supervision of the teacher.

- **Reinforcement activities.**

Non-contact marking character, through a virtual learning portal (Moodle) various activities that reinforce the basic contents of the subject be addressed. These activities can be customized or not, controlling their realization through it.

Defence profile

- Lectures: The topics addressed are the fundamental principles of electrical circuits, the operating principles of their elements, techniques and procedures for circuit analysis and study, and the operating principles of the most

common electrical machines, as well as basic selection criteria. Student participation is encouraged.

- Problem classes: In order to illustrate the application of different procedures and techniques presented during the lectures, several problem cases are solved with the active collaboration of students.
- Laboratory sessions: With the aim of achieving a meaningful learning, many of the concepts presented in the lecture sessions are applied in the laboratory. Many working techniques on electrical circuits are exercised in the laboratory, students acquire skills in the use of electrical measuring devices and they also acquire awareness of electrical hazards, being able to implement basic actions to avoid unsafe work conditions.
- Evaluable Activities: There are two types:
  - Some consist of the resolution by the students, in their study time, of different exercises proposed by the teacher. The correction and marking of these exercises provides information to students about the work that has developed.
  - The second type of assessment activities involves the resolution of brief questionnaires, for a certain time of a lecture session, that require the direct application of concepts to be seeing throughout the semester.

5.3.Program

SPECIALIZATION IN BUSINESS

The guidelines followed to develop the program of the course were as follows:
- Respect those proposed in the verification report content.
- Develop an agenda whose chapters are generally consistent with the titles of the specified program. When this was not done it was because of its size and / or correlation was included in another.
- Select a large bibliography of recognized technical, classical and current issues.
He selected the best literature topics treated and turned into a single text, design and own format, with innovative teaching resources. The teacher has not claimed to be unprecedented in its preparation, is based on texts by renowned, are only original objectives, organization and presentation of the material and drafting of some sections of the issues. The full text is available in the reprographic service of the school, as well as on digital media published in Moodle.
-The Main characteristics of text form can be summarized in eight subjects have, consistent with the content, completely developed, avoiding summaries.
-The Specific objectives achieved with the development of the text itself can be summarized as follows:

● Highlight the relationship between conceptual analysis and problem solving, using the number of examples needed to show approaches to solving them, stressing that solving is a process in which the conceptual knowledge is applied, and not It is merely a mechanized model for the solution. Therefore, in the text and the mental processes worked examples of problem solving based on the concepts, instead of highlighting the mechanical procedures are highlighted.

● Provide students practice in the use of analytical techniques presented in the text.
● Show students analytical techniques are tools, not goals, allowing quepractiquen in various situations in the choice of the analytical method they will use to obtain the solution.
● Encourage student interest in engineering activities, including real application problems.
● Develop problems and exercises using realistic values representing feasible situations.
● Encourage students to evaluate the solution, either with another method of resolution or by testing to see if it makes sense in terms of the known behavior of the circuit, machine or system.

30116 - Basic principles of electrical technology

● Show students how the results of a solution for additional encontrarinformación about the behavior of a circuit, machine or system are used.
● The resolution of most problems will require the type of analysis to be performed by an engineer to solve real-world problems. Developed examples, where the mindset own engineering emphasizes, also serve as a basis for solving real problems.

The subject is structured around two complementary components contents:
- Theorists.
- Practical.

THEORETICAL CONTENTS.
The choice of the content of the various teaching units was made seeking clarification express purpose terminal so that the union of incidents knowledge, the student obtain a structured, easily assimilable for this Engineers.
The theoretical contents are articulated based on eight teaching units attached table, indivisible blocks of treatment, given the configuration of the subject that program. These topics collect the contents needed for the acquisition of predetermined learning outcomes.

Topic 1	Agenda	**Basic electrical concepts.** **1.1 Introduction.** **1.2 Electrical circuit.** **1.3 Magnitudes involved in an electrical circuit.** **1.4 Types of tensions.**
	Study guide	Interpretation of electrical quantities in a circuit and the relationship between them. Knowledge and understanding of the concepts and physical principles of electricity, as well as their basic phenomena. Handling both units corresponding to different magnitudes and their relationships.

30116 - Basic principles of electrical technology

Topic 2	Agenda	**Direct current.** 2.1 Introduction. 2.2 Direct current generators. 2.3 Ohm's Law. 2.4 Association of resistors. 2.5 Voltage reductions. 2.6 Analysis of steady networks continuously.
	Study guide	Knowledge, understanding and application of the principles of direct current. Analysis and correct resolution of electrical circuits by applying laws and theorems.

30116 - Basic principles of electrical technology

Topic 3	Agenda	**Single Phase sinusoidal alternating current.** 3.1 Introduction. 3.2 Generation of alternating current sine wave. 3.3 Alternator. 3.4 Core values of sinusoidal alternating current. 3.5 Graphical representation of the sinusoidal alternating current. 3.6 Passive elements. His behavior in alternating current. 3.7 Generalized Ohm's law for alternating current. 3.8 Powers. 3.9 Circuits series. 3.10 Parallel circuits. 3.11 Improved power factor.
	Study guide	Knowledge, understanding and application of the principles of the single phase alternating current. Description and mathematical interpretation of the concept of sine wave, recognizing its importance in the study of electrical engineering. Recognition of the need for a right to successfully interpret physical phenomena that occur in alternating current and its practical consequences mathematical support. Interpretation of circuits, their design, their connections and deduction of error causes and ways to avoid them.
Topic 4	Agenda	**Three phase sinusoidal alternating current.** 4.1 Introduction. 4.2 Phase system of electromotive forces. 4.3 Load in a three phase system.

30116 - Basic principles of electrical technology

		4.4 Powers. 4.5 Improved power factor.
	Study guide	Knowledge, understanding and application of the principles of three phase alternating current. Recognition of the importance of alternating current progress and social welfare. Correctly interpreting circuit diagrams three phase alternating current, less in each case the electrical variables at play.
Topic 5	Agenda	**Single phase transformers.** 5.1 Introduction. 5.2 Main constructive aspects. 5.3 Basics of magnetism and electromagnetism. 5.4 Principle of operation of an ideal single-phase transformer. 5.5 Principle of operation of a real single-phase transformer. 5.6 Equivalent circuits. 5.7 Testing. 5.8 Voltage drop. 5.9 Performance.
	Study guide	Ideal load operation and load single phase transformer by its corresponding mathematical justification. Real idling and load single phase transformer and its implications. Process modeling of a single phase transformer with the necessary premises to carry out this process. Connotation of the various tests performed on single phase transformers.

30116 - Basic principles of electrical technology

Topic 6	Agenda	**Three phase transformers.** 6.1 Introduction. 6.2Transformación of a three-phase system for single-phase transformers. 6.3 Constructive aspects. 6.4 Operation. 6.5 Testing. 6.6 connections.
	Study guide	Extrapolation of the concepts studied for the single-phase transformer which have no place in the three phase transformer, ideal and actual operation, equivalent circuits, testing, voltage drop, performance, etc. Different combinations feasible in primary and secondary wirings of three phase transformers.

30116 - Basic principles of electrical technology

Topic 7	Agenda	**Direct current motors.** 7.1Introducción. 7.2 Constructive aspects of the current machine. 7.3 Principle of operation of the direct current machine. 7.4 induced electromotive force. 7.5 internal electromagnetic torque. 7.6 Reaction induced. 7.7 Switching. 7.8 Overview of the direct current motor. 7.9 Boot. 7.10 Classification of direct current motors. 7.11 Comparison of the main types of direct current motors. 7.14 speed control. 7.15 Reversing the direction of rotation. 7.16 Electrical braking.
	Study guide	Principles of generation of an induced electromotive force. Construction of the current machine and its operation as a motor. Analyze the various schemes of self excited generators. The drive effect and its relationship to torque production engines. Features and vacuum charging speed and torque. Starting torque of the different types of motors for applying appropriate loads
Topic 8	Agenda	**Three phase asynchronous motors.** 8.1Introducción. 8.2 Constructive aspects. 8.3 Rotating magnetic field produced by the stator winding. 8.4 Electromotive force induced in the windings. 8.5 Principle of operation of three phase asynchronous motor.

30116 - Basic principles of electrical technology

		8.6 Equivalent circuits. 8.7 Testing. 8.8 Balance of powers. 8.9 Rotation Torque. 8.10 Regimes operation of the asynchronous machine. 8.11 Curves electrical and mechanical fundamental characteristics. 8.12 Start of three-phase asynchronous motor. 8.13 Speed control.
	Study guide	Principle of operation, construction and operation of the asynchronous machine regimes. Highlights of the three phase asynchronous squirrel cage motor and wound rotor. Tests for obtaining the characteristic parameters of three phase asynchronous motor. Booting and speed regulation.

PRACTICAL CONTENTS.

Laboratory workshop are a very important for the formation of the student coursing the degree of civil ngineering complement. The engineer has to keep in mind always that only well-known that which can be measured, and, above all, accurately measure and if this is not possible, make the error that is being done reading.
The measurement and testing in electrical engineering cover a multitude of instruments that today have reached a high degree of perfection, through which it is possible to measure, monitor, investigate, e

It is impossible to try to give even a minimal description of the various types of appliances and commercial devices used for measuring various electrical parameters. This is not the purpose, but which are covered learning outcomes of the course through a comprehensive program of laboratory practices, encompassing aspects related to the following issues:
- Of Generically, you have a clear idea of the importance of the field of electrical measurements as well as the quality and accuracy of the measure being carried out, knowing the different types of errors that you may encounter when taking a reading.
- That knowledge has, at least, techniques and more used for measuring magnitudes as methods: voltage, current, power, energy, etc.

30116 - Basic principles of electrical technology

Those workshop to be developed in the laboratory, which will be performed by students in sessions of one hour below.

Workshop 1	**Measurement Resistance .** Application of methodologies: multimeter, voltamperimetro and Wheatstone bridge for measuring resistance.
Workshop 2	**Measurement capabilities.** Application of methodologies: multimeter, voltamperimetro Faraday and RC circuit for measuring capabilities.
Workshop 3	**Measurement inductances.** Application of methodologies: multimeter, voltamperimetro Joubert and RL circuit for measuring inductances.
Workshop 4	**Electrical measurements in sinusoidal steady series RLC circuit.** Determining fundamental electrical magnitudes involved in a series RLC circuit
Workshop 5	**Measure Direct current power.** Methodology for obtaining such magnitude direct current.
Workshop 6	**P ower measurement and power factor correction in a single phase circuit.** Both issues will be applied to a single phase motor starting phase.

Defence profile

Syllabus:

Topic 1: Kirchhoff's Laws.
1.1. Introduction.
1.2. Units.
1.3. Definitions.

30116 - Basic principles of electrical technology

1.4. References' polarity.
1.5. Kirchhoff's laws.

Topic 2: Elements of circuits.
2.1. Ideal elements of circuits.
2.1.1. Dipoles.
2.1.2. Quadripoles.
2.2. Real elements of circuits.

Topic 3: Power and energy.
3.1. Definitions.
3.2. Energy and power in dipoles.
3.3. Energy and power in quadripoles.

Topic 4: Circuit analysis methods.
4.1. Introduction.
4.2. Operational impedances and admittances.
4.3. Operational impedances and admittances association. Voltage divider and current divider.
4.4. Circuit representations.
4.5. Branch transformations.
4.6. Real source transformations.
4.7. Network circuit analysis methods.
4.7.1. Nodal analysis method.
4.7.2. Mesh analysis method.

Topic 5: Fundamental theorems.
5.1. Introduction.
5.2. Superposition theorem.
5.3. Thevenin's theorem.
5.4. Norton's theorem.

Topic 6: Sinusoidal steady state electric circuit analysis.
6.1. Introduction.
6.2. Sinusoidal voltage generation.
6.3. Sinusoidal waveforms. Properties.
6.4. Circuits supplied with sinusoidal sources.
6.5. Determination of the sinusoidal steady state.
6.6. Complex impedances and admittances. Complex impedances association.
6.7. Passive components in sinusoidal steady state.
6.8. Kirchhoff's Laws in sinusoidal steady state.
6.9. Methods of circuit analysis in sinusoidal steady state.
6.10. Fundamental theorems in sinusoidal steady state.
6.11. Basic circuits in sinusoidal steady state.

Topic 7: Power in sinusoidal steady state circuits.
7.1. Instantaneous power.
7.2. Instantaneous power in basic passive dipoles.
7.3. Power in sinusoidal steady state. Power triangle.
7.4. Complex power in the passive dipoles.
7.5. Power factor.
7.6. Theorems related with power in sinusoidal steady state.
7.7. Power measurement.

Topic 8: Balanced three-phase systems.
8.1. Introduction.
8.2. Generating a three-phase system.
8.3. Wye and delta connections.
8.4. Three-phase systems schemes.
8.5. Voltages and currents in three-phase systems.
8.6. Balanced three-phase systems.

Topic 9: Fundamentals of electric machines. Selection and application.
9.1. Introduction: definition and classification.
9.2. General constitution of a transformer.
9.3. Transformers selection.

5.4.Planning and scheduling

SPECIALIZATION IN BUSINESS

The subject has 6 ECTS credits, which represents 150 hours of student work in the subject during the trimester, in other words, 10 hours per week for 15 weeks of class.

A summary of a weekly timetable guide can be seen in the following table. These figures are obtained from the subject file in the Accreditation Report of the degree, taking into account the level of experimentation considered for the said subject is moderate.

Activity	Weekly school hours
Lectures	3
Laboratory	1
Others activities	6

Nevertheless the previous table can be shown into greater detail, taking into account the following overall distribution:

— 45 hours of lectures, with 50% theoretical demonstration and 50% solving type problems.

30116 - Basic principles of electrical technology

— 10 hours of laboratory workshop, in 1 or 2 hour sessions.

— 5 hours of written assessment tests, one or two hour per test.

— 90 hours of personal study, divided up over the 15 weeks of the semester.

The dates of the global evaluation test will be published officially in
http://www.eupla.unizar.es/index.php/secretaria-2/informacion-academica/distribucion-de-examenes

Written continuous assessment tests are related to the following topics:

Las pruebas escritas de evaluación continua estarán relacionadas con los temas siguientes:

— **Written assessment test 1** : Topics 1, 2, 3 y 4.

— **Written assessment test 2** : Topics 5, 6, 7 y 8.

The issues on which the work will be developed will be proposed in the third week, carrying out delivery and exposure before the last two weeks teaching in the course of the signature dates will be specified.

The most significant dates in the system of continuous assessment are contained in the following indicative timetable and may vary depending on the development, subject to the academic calendar lesson activity.

Activity	**Weekly school**													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Test 1								X						
Test 2														
Work			P											

30116 - Basic principles of electrical technology

P: proposed works E: delivery works

Resources and materials used in the development of the subject are reflected in the following table:

Material	Format
Topic theory notes Topic problems	Paper/repository
Topic theory notes Topic presentationso Topic problems Related links	Digital/Moodle E-Mail
Circuit simulation software	Pc's laboratorio
Technical manuals	Paper/repository Digital/Moodle
Multimeters ammeters Voltmeters Power Meters Frequency Transformers. Rectifiers Oscilloscopes Single and three phase loads Engines	

Defence profile

30116 - Basic principles of electrical technology

Lectures and problem classes, and the laboratory sessions are held according to schedule established by the Centre and available on the website of Centro Universitario de la Defensa (http://cud.unizar.es).

The other activities of the course are announced well in advance through the Moodle platform (http://moodle2.unizar.es).

5.5.Bibliography and recomended resources

BB	Chapman, Stephen J.. Máquinas eléctricas / Stephen J. Chapman ; revisión técnica Carlos Rodríguez Pérez, Alfredo Santana Díaz . - 5ª ed. México [etc.] : McGraw-Hill, cop. 2012
BB	Cortes Cherta, M.. Máquinas de corriente continua/ Manuel Cortés Cherta.. - 1ª edición Barcelona: Editores Técnicos Asociados,1994.
BB	Cortes Cherta,M.. Máquinas de corriente alterna asíncronas/Manuel Cortés Cherta.. - 1ª edición Barcelona:Editores Técnicos Asociados,1994
BB	Fraile Mora, Jesús. Máquinas eléctricas / Jesús Fraile Mora . - 5ª ed. en español Madrid : McGraw-Hill/Interamericana de España, cop. 200
BB	Gómez Alós, Milagros. Problemas resueltos de máquinas eléctricas / Milagros Gómez Alós, Alfonso Bachiller Soler, Guillermo Ortega Gómez . - 2ª ed. Madrid : Cengage Learning Paraninfo, D. L. 2008
BB	Problemas de electrotecnia. 1, Teoría de circuitos / X. Alabern Morera ...[et al.] Madrid : Paraninfo, 1991
BB	Problemas de electrotecnia. 2, Circuitos trifásicos / X. Alabern Morera ...[et al.] Madrid : Paraninfo, 1991
BB	Sanjurjo Navarro, Rafael. Máquinas eléctricas / Rafael Sanjurjo Navarro Madrid [etc.] : García Maroto, D.L. 2011
BB	Staff, E. E.. Circuitos magnéticos y transformadores / E.E. Staff [del M.I.T] Barcelona [etc.] : Reverté, 1965
BC	Bachiller Soler, Alfonso. Problemas resueltos de circuitos trifásicos. Parte I /

30116 - Basic principles of electrical technology

	Alfonso Bachiller Soler, Ramón Cano González, Narciso Moreno Alfonso. - 1ª edición Sevilla : Narciso Moreno Alfonso, 2005
BC	Bayod Rújula, Ángel Antonio. Circuitos monofásicos y trifásicos en régimen estacionario senoidal / Ángel Antonio Bayod Rújula, Mariano Sanz Badía. - [1a. ed.] Zaragoza : Prensas Universitarias de Zaragoza, 1997
BC	Fraile Mora, Jesús. Electromagnetismo y circuitos eléctricos : Curso de Electrotecnia / J.Jesús Fraile Mora . - 3ª ed. [Madrid] : Colegio de Ingenieros de Caminos, Canales y Puertos, 1995
BC	González Estévez, Emilio. Ejercicios resueltos de circuitos eléctricos / Emilio González Estévez, Carlos Garrido Suárez, José Cidrás Pidre. - 1ª edición La Coruña] : Tórculo, 1999
BC	González Estévez, Emilio. Ejercicios resueltos de circuitos eléctricos. T.2 / Emilio González Estévez, Carlos Garrido Suárez, José Cidrás Pidre. - 1ª edición Santiago de Compostela : Tórculo, 1999
BC	Problemas resueltos del curso de electrotécnia. Parte 2, Máquinas eléctricas : (Se incluyen también líneas eléctricas) [Madrid] : Universidad Politécnica, E.T.S. de Ingenieros de Caminos, Canales y Puertos, Cátedra de Electrotecnia, [199?]
BC	Rosell Polo, Joan Ramon. Circuitos eléctricos monofásicos y trifásicos :fundamentos teóricos y ejercicios resueltos / Joan Ramon Rosell Polo. - 1ª edición Lleida : Edicions de la Universitat de Lleida, DL 2000
BC	Sanjurjo Navarro, Rafael. Teoría de circuitos eléctricos / Rafael Sanjurjo Navarro, Eduardo Lázaro Sánchez, Pablo de Miguel Rodríguez . - [1a. ed. en español] Madrid [etc.] : McGraw-Hill, D.L. 1997

Defence profile :

BB	Análisis de circuitos eléctricos I / Ángel Antonio Bayod Rújula ... [et al.] . - 2ª ed. Zaragoza : Prensas Universitarias de Zaragoza, 2007
BB	Bayod Rújula, Ángel Antonio. Análisis de circuitos trifásicos en régimen estacionario senoidal / Angel Antonio Bayod Rújula Zaragoza: Prensas Universitarias de Zaragoza, 2005
BB	Bayod Rújula, Ángel Antonio. Circuitos monofásicos en régimen estacionario senoidal/ Angel Antonio Bayod Rújula . 1ª ed. Zaragoza: Prensas Universitarias de

30116 - Basic principles of electrical technology

	Zaragoza, 2005
BB	C. Garrido y J. Cidrás. Problemas de circuitos eléctricos. 1ª ed. Reverté
BB	Circuitos eléctricos. Vol. I / Antonio Pastor Gutiérrez ... [et al.] . - 1ª ed., 4ª reimp. Madrid : Universidad Nacional de Educación a Distancia, imp. 2007
BB	Fraile Mora, Jesús. Máquinas eléctricas / Jesús Fraile Mora . - 6ª ed. Madrid : McGraw-Hill/Interamericana, cop. 2008
BB	Problemas de fundamentos de electrotecnia / Miguel Ángel García García, Joaquín Mur Amada, Nabil El Halabi, Iván Cristóbal Monreal . - 1ª ed. Zaragoza : Centro Universitario de la Defensa, 2013
BB	Usaola García, Julio. Circuitos eléctricos : problemas y ejercicios resueltos / Julio Usaola García, Mª Angeles Moreno López de Saá Madrid [etc.] : Prentice Hall, D.L. 2002
BC	Alexander, Charles K. Fundamentos de circuitos eléctricos / Charles K. Alexander, Matthew N. O. Sadiku ; traducción Aristeo Vera Bermúdez, Carlos Roberto Cordero Pedraza ; revisión técnica Francisco Martín del Campo . - 3ª ed. México D. F. : McGraw-Hill Interamericana, cop. 2006
BC	Circuitos eléctricos para la ingeniería / Antonio J. Conejo ... [et al.] Madrid [etc.] : McGraw-Hill, D.L. 2004
BC	Fundamentos de teoría de circuitos / Antonio Gómez Expósito ... [et al.] . - 1ª ed., 2ª reimp. Madrid : Thomson Paraninfo, 2008
BC	Sanz Feito, Javier. Máquinas eléctricas / Javier Sanz Feito Madrid [etc.] : Prentice Hall, D.L. 2002