PERSONA CIÈNCIA EMPRESA
UNIVERSITAT RAMON LLULL

COURSE: ELECTRICAL ENGINEERING

SUBJECT MATTER: Fundamentals of Electrical and Electronic Engineering
MODULE: Core Topics of Industrial Engineering
PROGRAM: Degree in Chemical Engineering

GENERAL CHARACTERISTICS

Type: ☐ Basic Formation, ☑ Compulsory, ☐ Elective
☐ Final Degree Project, ☐ Internship

Duration: Semestral **Semester/s**: 6
Number of ECTS credits: 4
Language/s: Catalan, Spanish, English

DESCRIPTION

SHORT DESCRIPTION AND JUSTIFICATION

The study of electrical circuits plays an important role in the knowledge of electrical and electronic engineering. In the first part of this subject, the fundamentals of electrical circuits is provided, as well as their operation and the analysis techniques that let us solve them in direct current. In the second part of this subject the alternating current is studied, as well as the three-phase electrical systems. Finally, the main typologies of electrical machines that are connected to those systems are explained. The knowledge of three-phase systems is essential because nowadays the generation, transport and distribution of electrical energy are done by means of three-phase power systems. Finally, electrical machines are very common nowadays because electrical energy is a clean and efficiency source, it is easy to control and it has the possibility of being transmitted through large distances.

COMPETENCES

Basic competences:

1. Students must prove that they have got and understood the knowledge in a field which goes from the general secondary education and they usually find it in a level that, although relying on advanced textbooks, it also includes some aspects that imply knowledge that comes from the avant-garde of their field of study [CB1].
2. Students must know how to apply their knowledge into their work or vocation in a professional way and they must have the skills that are usually proved by means of the elaboration and advocacy of arguments and the problem solving inside their field of study [CB2].

Specific competences:

1. Students must be able to understand and apply knowledge of Chemical and Engineering for their application into the field of Chemical Engineering [E2].

2. Students must be able to identify, formulate and solve basic problems of Mathematics, Chemical, Physics, Informatics, Biology, Economy and Graphical Expression and problems in the fields of Chemical Engineering and Chemical [E7].
3. Knowledge and use of the principles of circuits' theory and electrical machines [CR4].
4. Knowledge on the fundamentals of electronics [CRI5].
5. Knowledge on the fundamentals of automatisms and control methods [CRI6].

PREREQUISITES

According to current academic teaching planning and regulations.

CONTENTS

Unit 1. Introduction to the analysis of electrical circuits

1. Basic electrical quantities
2. Circuit elements
3. Ohm's law
4. Joule's law
5. Open circuit and short circuit
6. Resistor connections

Unit 2. General methods to solve electrical circuits

1. Kirchhoff's current law
2. Kirchhoff's voltage law
3. Nodal analysis
4. Mesh analysis

Unit 3. General theorems to solve electrical circuits

1. Equivalence
2. Linearity
3. Superposition
4. Thevenin's and Norton's theorems
5. Maximum power transfer

Unit 4. Energy storage components

1. Inductors
2. Capacitors

Unit 5. Electrical circuits in sinusoidal steady state

1. Sinusoidal function
2. Phasors
3. Impedance and admittance
4. Phasor diagrams
5. Circuit analysis in alternating current
6. Mutual inductance
7. Power in alternating current
8. Power factor correction

Unit 6. Three-phase systems

1. Introduction
2. Definitions
3. Balanced three-phase systems
4. Power in three-phase systems

Unit 7. Magnetic circuits and electrical machines

1. Magnetic circuits
2. Basic components of electrical machines
3. Ring collector and commutator
4. Windings
5. Rated power and power losses
6. Ferraris' theorem
7. Faraday's law
8. Electrical machines classification

METHODOLOGY

LEARNING ACTIVITIES

Learning activities	Hours	ECTS Credits	Competences
Lectures	30	1.5	E2, CRI4, CRI5, CRI6
Case and Problem-Solving Sessions	11	0.5	E2, E7, CRI4
Seminars		-	-
Practical & Lab Work	11	0.5	CRI4, CRI5, CRI6
Presentations		-	-
Personal study		1.25	E7, CRI4, CRI5, CRI6
Assessment Tasks (Exams, Continuous Assessment...)	5	0.25	E2, E7, CRI4, CRI5
TOTAL		**4.0**	

TEACHING METHODOLOGY

This subject is taught by conducting lectures, in which the professor explains the basic concepts for each unit and problem-solving classes, in which the students must consolidate the knowledge and methods that have been previously taught in the lectures by means of solving electrical circuits. On the other hand, through the course the students must do three midterm exams, in which they should show their knowledge on the subject by solving electrical circuits. Previously to these midterm exams, the students will have to solve and handed in a collection of exercises, with the aim to work on their own. Moreover, for a better understanding of the theoretical concepts, students will have to conduct assemblies and/or simulations in the lab on the operation of electrical circuits. At the end of the lab sessions, the students must hand in a report with the obtained results.

ASSESSMENT

ASSESSMENT METHODS

Assessment Methods	Weight	Competences
Final Exam	45%	E2, E7, CRI4, CRI5
Midterm Exam/s	30%	E2, E7, CRI4, CRI5
Follow-up Activities	15%	E2, E7, CRI4, CRI5
Reports and Presentations	-	-
Lab or Field Work	10%	CRI4, CRI5, CRI6
Projects	-	-
Host Student Evaluation	-	-
Participation	-	-

LEARNING OUTCOMES

- The student must prove theoretical understanding of the basic concepts on electricity and electrical systems [E2, E7, CRI4].
- The student must prove adequacy on the understanding, approach and resolution of electrical circuits and electrical power systems [E2, E7, CRI4].
- The student must prove theoretical understanding of the basic concepts on electronics, automatisms and control systems [E2, E7, CRI5, CRI6].

QUALIFICATION

The final mark of the course (FM) is the addition of the continuous assessment (CA) and the final exam (FE). The continuous assessment (CA) consists of the marks of the three midterm exams (ME1, ME2 and ME3), the solved exercises (SE) and the experimental work (EW). The weights of each of these parts in the final mark are:

$$FM = 0.55\ CA + 0.45\ FE$$

$$CA = 0.3\ (ME1 + ME2 + ME3) + 0.15\ SE + 0.1\ EW$$

However, in order to pass the course, students must obtain a minimum grade in both continuous assessment (CA) and final exam (FE). In both cases, students must obtain a minimum grade of 4 out of 10. Finally, from the third call (inclusive), the continuous assessment will not be taken into account, so the final mark of this subject will be the same as the mark obtained in the final exam of the corresponding call.

ASSESSMENT OF THE COMPETENCES

- For the evaluation of E2 and E7 competences, the indicator will be the marks of midterm exams, the mark of the final exam and the mark of the monitoring activities.
- For the evaluation of CRI4 and CRI5 competences, the indicator will be the marks of midterm exams, the mark of the final exam, the mark of the monitoring activities and the mark of the experimental work.
- For the evaluation of CRI6 competence, the indicator will be the mark of the experimental work.

BIBLIOGRAPHY

Basic references:

- IRWIN, J. David: "Análisis básico de circuitos en ingeniería". 6th Ed., Mexico: Limusa-Wiley, 2003.
- BELENGUER, Enrique; BELTRÁN, Héctor; FORTANET, David; PÉREZ, Emilio; ROLÁN, Alejandro and SANSANO, Juan: "Problemas resueltos de teoría de circuitos". Barcelona: Marcombo, 2015.
- FRAILE, Jesús: “Máquinas eléctricas”. 6th Ed., Madrid: McGraw-Hill, 2008.

Further reading:

- NILSSON, James W.: "Circuitos eléctricos". 7th Ed., Mexico: Pearson Education, 2005.
- PARRA, Valentín M.: "Teoría de circuitos". 7th Ed. (2 vol.), Madrid: UNED, 1991.
- RAS, Enrique: "Teoría de circuitos: fundamentos". 4th Ed., Barcelona: Marcombo Boixareu, 1987.
- FRAILE, Jesús: "Circuitos eléctricos", Madrid: Pearson Educación, 2012.
- FRAILE, Jesús: “Problemas de máquinas eléctricas”. Madrid: McGraw-Hill, 2005.
- ALABERN, Xavier; HUMET, Lluís; NADAL, Josep M.; ORILLE, Ángel L. and SERRANO, J. A.: "Problemas de electrotecnia. 1. Teoría de circuitos". Madrid: Paraninfo, 1991.
- ALABERN, Xavier; HUMET, Lluís; NADAL, Josep M.; ORILLE, Ángel L. and SERRANO, J. A.: "Problemas de electrotecnia. 2. Circuitos trifásicos". Madrid: Paraninfo, 1991.
- SÁNCHEZ, Paulino: "Teoría de circuitos: problemas y pruebas objetivas orientadas al aprendizaje". Madrid: Pearson Educación, 2007.

DOCUMENT HISTORY

PREVIOUS REVISION
January 25, 2018, Prof. Alejandro Rolán, Ph.D.
June 19, 2017, Prof. Alejandro Rolán, Ph.D.
July 21, 2016, Prof. Alejandro Rolán, Ph.D.
January 31, 2016, Prof. Alejandro Rolán, Ph.D.
March 2015, Prof. Juan Antonio Tormo.

CURRENT REVISION
June 18, 2018, Prof. Alejandro Rolán, Ph.D.