TITLE OF COURSE: ELECTRICAL TECHNOLOGY

MATTER: Electrical Engineering
MODULE: Process engineering and product
PROGRAM TITLE: Master in Chemical Engineering

GENERAL CHARACTERISTICS*

Type: ☐ Basic training, ☑ Compulsory elective, ☐ Optional

☐ Master thesis, ☐ Internship

Duration: Quaterly **Semester/s**: 2
Number of credits ECTS: 3
Language/s: English

DESCRIPTION

BRIEF DESCRIPTION AND JUSTIFICATION (the meaning of the course in relation to the studies. Between 100 and 200 words.)

The knowledge of the fundamentals of electrical machines is necessary for any engineer, regardless of his/her speciality because in a direct or indirect way he/she will be in touch with systems of generation, transport and/or consumption of electrical energy. This subject begins with the study of the concept of electrical power system in order to understand the contribution of the electrical machines as a whole. Later, the constitutive aspects and the principle of operation of conventional electrical machines are described: transformers, asynchronous (or induction) machines, synchronous machines and direct current machines. The subject is focused on obtaining and analysing the equivalent circuits of all the electrical machines, as well as the power balance that is involved in the electromechanical systems that constitutes any electrical machine, obviating the concepts that are related to their design.

COMPETENCES (of the course made in relation to preassigned competences in this area.)

Basic competences:

1. To have and to understand the knowledge that provides a basis or opportunity for being original in the development and/or in the application of ideas, often in a research context [CB6].
2. Students must be able to apply their acquired knowledge and their problem-solving ability either in new or in unfamiliar environments inside wider contexts (or multidisciplinary ones) related to their area of study [CB7].
3. Students must be able to design, manage, develop and present a project [CG1].

Specific competences:

1. To apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, acquired by means of study, experience and practice, with critical thinking to establish solutions economically viable to technical problems [CE1].
2. To design products, processes, systems and services of the chemical industry, as well as the optimization of other ones that are already developed, taking as technological basis the different areas of chemical engineering, comprising the

processes and transport phenomena, separation operations and engineering of chemical reactions, nuclear, electrochemistry and biochemistry [CE2].

3. To manage and to supervise any kind of installations, processes, systems and services of the different industrial areas that are related to Chemical Engineering [CE5].

PREREQUISITES* (modules, matters, subjects or knowledge needed to follow the course. The courses that must be completed can also be stated.)

Calculation tools. Behaviour of electrical circuits. Techniques to solve electrical circuits. Electromagnetic field theory. Three-phase systems.

CONTENTS (as a relation of the chapters that constitute the contents, or topics covered, of the course to a second level of detail.)

Unit 1. Fundamentals of electric power systems
1. Definition of electric power system (EPS)
2. Components of an EPS
3. Voltage levels
4. Regulations

Unit 2. Fundamentals of 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

Unit 3. Transformers
1. Constitutive aspects
2. Principle of operation
3. Equivalent circuit
4. Tests
5. Losses and efficiency
6. Three-phase transformers
7. Transformers working in parallel
8. Self-transformers
9. Measuring transformers

Unit 4. Asynchronous (or induction) machines
1. Constitutive aspects
2. Principle of operation
3. Equivalent circuit
4. Tests
5. Power balance
6. Rotating torque
7. Starting
8. Speed regulation

Unit 5. Synchronous machines
1. Constitutive aspects
2. Principle of operation
3. Equivalent circuit
4. Connection to an infinite-power grid
5. Alternators working in parallel
6. Alternators and transformers in an EPS

Unit 6. Direct current machines
1. Constitutive aspects
2. Principle of operation
3. Direct current generator
4. Direct current motor
5. Alternating motor with commutator

METHODOLOGY

TRAINNING ACTIVITIES* (Fill in the table relating activities, workload in ECTS credits, and competences.)

Training activities	ECTS Credits	Competences
Sessions presentation of concepts	0.75	CB6, CE1, CE2, CE5
Sessions for resolution of exercises, problems and cases	0.5	CB7, CE1, CE2
Seminars	-	-
Personal mandatory activities professor-student	-	-
Practical work / laboratory	0.5	CB6, CG1
Oral and writing presentations	0.1	CB7, CG1, CE1
Personal study activities by students	1.0	CB6, CB7, CE1
Evaluation activities (exams, tests…)	0.15	CB6, CE1
TOTAL	**3.0**	

* These characteristics should not be changed without the approval of the responsible for higher level academic structures (matter, module and/or syllabus).

EXPLANATION OF THE TEACHING METHODOLOGY (justifying the teaching methods used in relation to the competences and course contents. Between 100 and 200 words.)
This subject is taught by conducting lectures, in which the teacher 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 the resolution of practical exercises. On the other hand, through the course two midterm exams will take place, with the aim for the student to keep up to date with the subject. Moreover, for a better understanding of the theoretical concepts, the students will have to conduct assemblies and/or simulations in the lab about the behaviour of electrical machines. Finally, this subject also contemplates the performing of a work inside a team, whose topic and date of delivery will be given in class by the teacher. It should be noted that the student's participation in class will be assessed positively.

EVALUATION

EVALUATION METHODS* (Fill in the table relating evaluation methods, competences and weight in the qualification of the subject.)

Evaluation methods	Weight	Competences
Final exam	45%	CB7, CE1, CE2
Midterm exams	30%	CB7, CE1, CE2
Monitoring activities	-	-
Works and presentations	10%	CB6, CG1, CE5
Experimental work	5%	CB6, CG1
Projects	-	-
Valuation of the company or institution	-	-
Participation	10%	CB7, CE1

LEARNING OUTCOMES (Explanation of the achievements of students that allow competences evaluation, relating to competences and evaluation methods.)

- Knowledge that gives the student the basis or opportunity to be original in the development and/or application of ideas [CB6].
- Ability to apply the acquired knowledge [CB6].
- Ability to solve problems either in new or in unfamiliar environments inside wider contexts (or multidisciplinary ones) related to their area of study [CB7].
- Ability to design and develop a project [CG1].
- Ability to apply the acquired knowledge with critical thinking in order to establish solutions economically viable to technical problems of electricity in industrial installations [CE1].
- Ability to design systems and electrical services in the chemical industry and related ones [CE2].

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- To manage and to supervise electrical installations in the different industrial areas which are related to Chemical Engineering [CE5].

EVALUATION (Explanation of the calculation system of qualifying the course.)

The final mark of the course (FM) is the addition of the final exam (FE) and the continuous assessment (CA). The continuous assessment (CA), meanwhile, consists of the marks of the two midterm exams (ME1 and ME2), the final project (FP), the experimental work (EW) and the student's participation (SP). The weights of each of these parts in the final mark are:

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

$$CA = 0.15\ ME1 + 0.15\ ME2 + 0.1\ FP + 0.05\ EW + 0.1\ SP$$

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.

EVALUATION OF COMPETENCES (Define expressions of calculation for each competence based on corresponding evaluations activities.)

- For the evaluation of CB6 competence, the indicator will be the marks of the final work and the experimental work.
- For the evaluation of CB7 and CE1 competences, the indicator will be the marks of the final exam, the midterm exams and the student's participation.
- For the evaluation of CE2 competence, the indicator will be the marks of the final exam and the midterm exams.
- For the evaluation of CEE competence, the indicator will be the mark of the final work.
- For the evaluation of CG1 competence, the indicator will be the marks of the final work and the experimental work.

TEXTBOOKS (recommended and accessible to students.)

Basic references:

- FRAILE, Jesús: "Máquinas eléctricas". 6th Ed., Madrid: McGraw-Hill, 2008.
- FRAILE, Jesús: "Problemas de máquinas eléctricas". Madrid: McGraw-Hill, 2005.
- STEVENSON, William D. and GRAINGER, John J.: "Análisis de sistemas de potencia". 2nd Ed., Mexico: McGraw-Hill, 1996.

Further reading:

- CHAPMAN, Stephen J.: “Máquinas eléctricas”. 5th Ed., Mexico: McGraw-Hill, 2012.
- CORTÉS, Manuel, CORRALES, Juan and ENSEÑAT, Alfonso: “Teoría general de máquinas eléctricas”. 3rd Ed., Madrid: UNED, 2002.
- BARRERO, Fermín: “Sistemas de Energía Eléctrica”. Madrid: Paraninfo, 2004.

DOCUMENT RECORD

PREVIOUS CHANGES (Indicate date and author/s, newest first.)
June 19, 2017, Prof. Alejandro Rolán, Ph.D.
July 22, 2016, Prof. Alejandro Rolán, Ph.D.
February 16, 2016, Prof. Alejandro Rolán, Ph.D.

LAST REVISION (Indicate date and author/s.)
June 18, 2018, Prof. Alejandro Rolán, Ph.D.