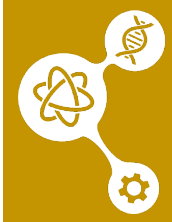
Academic year
2026/2027

Course Guide:

ELECTRICAL ENGINEERING AND AUTOMATION



FACULTY OF
CHEMICAL SCIENCES

1. IDENTIFICATION

Degree Programme	Bachelor's Degree in Chemical Engineering.			Course Code	801552
Course Name	Electrical Engineering and Automation			ECTS	6
Subject Area	Engineering Bases				
Module	Industrial Engineering				
Course Type	Compulsory	Year	Fourth Year	Semester	First Semester
Department	Computer Architecture and Automation (Physical Sciences)				

Teaching Staff

Activity	Lecturer	Email	Office
Lectures/ Seminars /Tutorials	JUAN JIMÉNEZ CASTELLANOS	juan.jimenez@fis.ucm.es	FIS-222 (Faculty of Physics)

2. OBJECTIVES

General objective

The objective of this subject is the study of different concepts, methods and applications of physics in industry. In particular, it focuses on the generation, transportation and distribution of electrical energy, incorporating general notions of industrial automation.

Specific objectives

- Understand the global process of generation, transportation and distribution of electrical energy.
- Know and solve direct current electrical circuits.
- Know and solve electrical circuits in alternating current.
- Calculate the power in an electrical circuit.
- Solve balanced three-phase systems. Know the reason for its existence.
- Know the basic principles of magnetism and magnetic circuits as the basis of electrical machines.
- Know transformers and their role in the transportation of electrical energy.
- Understand the operation of synchronous generators as an example of electrical energy generation.
- Understand the operation of induction motors.
- Acquire some basic notions of industrial automation.
- Have a general idea of the low voltage electrotechnical regulations.

3. PRIOR KNOWLEDGE AND RECOMMENDATIONS

Prior knowledge

Proper follow-up of this subject requires that the student has previously acquired the knowledge and skills corresponding to the following subjects: Physics, Applied Computing, Mathematics I and Mathematics II. Although enrolment is not formally conditioned by this prior learning, effective mastery of said knowledge is essential to take this subject with reasonable possibilities of achievement.

Recommendations

It is recommended that the student have a basic level of English that allows them to handle bibliography in English, search for information and communicate in writing and orally in that language. Likewise, it is recommended that you be familiar with computer tools and programs for solving complex problems, as well as applications for writing, editing, and presenting technical reports. Furthermore, for a better use of the subject, it is recommended to have basic concepts of electricity and magnetism.

4. CONTENTS

Brief description

Generation, transportation and distribution of electrical energy. Low voltage electrotechnical regulation. Electrical circuits. AC. Three-phase current. Electric machines. Electric motors. Transformers. Components of an electronic circuit. Automatic.

Course syllabus

Block I: ELECTRICAL CIRCUITS

Topic 1. Introduction

Introduction. Elements of electrical circuits: passive and active. Passive Sign Convention. Kirchhoff's laws. Modelling of an electrical circuit.

Topic 2: Alternating current in sinusoidal steady state

Alternating current in sinusoidal steady state. Representation of electrical circuits using phasors. Operations with phasors.

Topic 3: Power

Power classes. Power triangle. Boucherot's theorem. Power measurement.

Topic 4: Balanced Three-Phase Systems

Three-phase voltages. Single-phase systems. Three-phase systems. Star and triangle connections. Measurement of active and reactive powers.

Block II: ELECTRICAL MACHINES

Topic 5: Principles of Electric Machines

Basic principles of magnetism. Faraday's Law. Hysteresis and Eddy Currents.

Topic 6: Transformers

Ideal and real transformers. Equivalent circuits and phasor diagrams. Analysis of losses. Transformer testing. Performance. Voltage regulation.

Topic 7: Fundamentals of Alternating Current Machines

General principles of electromagnetic energy conversion. Operation of alternating current machines. Electromagnetic pair.

Topic 8: Synchronous Generators

The alternating current generator. Construction. Operating principle. Induced electromotive force and factors that affect it. Magnetomotive armature reaction force. Alternator vector diagram. Regulation. Performance.

Topic 9: Induction Motors.

Three-phase asynchronous motors. Rotating fields. Rotor in rotating magnetic field. Equivalent circuit. Asynchronous motor test.

Block III: LOW VOLTAGE ELECTROTECHNICAL REGULATION

Topic 10: Low Voltage Electrotechnical Regulations

Electrical safety. Fundamentals and articles. Technical Application Guide.

Block IV: AUTOMATIC

Topic 11: Basic Principles of Industrial Automation

History. Basic Fundamentals. The Control Loop. Applications in industry production processes.

5. COMPETENCES

General competences

CG1-MII4	Apply the principles of circuit theory and electrical machines.
CG6-MII6	Use the fundamentals of automation systems and control methods.

Specific competences

CE10-B1	Describe systems for the generation, transmission, and distribution of electrical energy.
CE10-B2	Select both the type and characteristics of the electrical machines required for any application.
CE10-B3	Choose the protection devices required to protect electrical installations.
CE10-B4	Explain the fundamentals of automation and interpret basic automation diagrams.

Cross-cutting competences

CT2-II1	Demonstrate capacity for analysis and synthesis in Industrial Engineering.
CT4-II1	Communicate in Spanish using standard audiovisual media.
CT5-II2	Use bibliography, specialised databases and resources accessible through the Internet.
CT6-II1	Use computer programs to calculate, design, simulate, approximate, and predict.
CT7-II1	Work in a team.
CT10-II1	Integrate acquired knowledge and apply it to solving problems in Industrial Engineering.
CT11-II1	Learn autonomously.
CT13-II1	Demonstrate initiative and creativity in solving new situations.

6. WORKLOAD DISTRIBUTION BY ACTIVITY.

Activity	In-class (hours)	Self-study (hours)	Credits
Lectures	35	60	3,8
Seminars	10	25	1,4
Tutorials/guided work	4	6	0,4
Coursework and examination preparation	3	7	0,4
Total	**52**	**98**	**6**

7. METHODOLOGY

The teaching practice will follow a mixed methodology based on cooperative learning, collaborative learning and self-learning. This methodology will be developed through theoretical classes, seminar classes, individual or group work and guided tutorials.

The theoretical classes, which will be carried out in a single group, will consist, as a priority, of master classes in which the complete syllabus of the subject will be presented in an orderly manner with the help of audiovisual material. Part of the recommended bibliography and the support material that is deposited in the virtual campus for the development of the teaching activities of this subject will be in English.

The seminars will consist of the formulation and resolution of problems, previously proposed to the student, that involve the application of theoretical knowledge, as well as the development of some complementary and eminently practical topics. Likewise, students will have the opportunity to solve problems and present work, demonstrating their ability to express themselves in public. A part of these activities will be carried out in English. Matlab will be used in problem solving.

The tutorials will consist of directing and supervising the progress of the students in their personalized work, as well as resolving doubts raised and carrying out practical tests. A part of these activities will be carried out in English.

The UCM Virtual Campus will be used as an instrument to make available to students the material that will be used in theoretical classes, seminars, tutorials and laboratories, and as a means of communication between the professor and the students.

8. BIBLIOGRAPHY

Basic bibliography

- Nillson, J.W. and Riedel, S.: “Electric Circuits”, 12th Edition. Ed. Pearson.
- Chapman, J. S.: “Electric Machinary Fundamentals”, 5th Edition. Ed. McGraw-Hill.
- Stephen L. Herman: “Electrical Transformers and Rotating Machines.” 4th Edition. Ed. CENGAGE
- Atif Iqbal, Shaikh Moinoddin, B. Prathap Reddy: “Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK”, 1st Edition. Ed. Wiley
- Paul C. Krause, Thomas C. Krause: “Introduction to Modern Analysis of Electric Machines and Drives, 1st Edition.” Ed. Wiley
- Low voltage electrotechnical regulation. Royal decree 842/2002.

Complementary bibliography

- Martin J. Heathcote: "J & P Transformer Book. A Practical technology of the Power transformer", 13th Edition. Ed Elsevier
- Daniel S. Kirschen: “Power Systems: Fundamental Concepts and the Transition to Sustainability” 1st Edition. Ed Wiley.

9. EVALUATION

For the final evaluation, participation in the different proposed activities is mandatory. It is mandatory to attend all guided tutorials. In order to access the final evaluation, it will be necessary for the student to have participated in at least 70% of the face-to-face classroom activities.

The student's academic performance and the final grade for the subject will be computed, in a weighted manner, taking into account the percentages shown in each of the aspects listed below.

❖ WRITTEN EXAMINATION: 70%

The evaluation of the skills acquired in the subject (CG1-MII4, CG6-MII6, CE10-B1, CE10-B2, CE10-B3, CE10-B4) will be carried out by taking two written exams in the ordinary and extraordinary call, of a mainly practical nature, which will represent 70% of the overall evaluation. This exam will consist of a theoretical part (40% score) and a problem part (60%).

It will be necessary to obtain a minimum score of 4.0 points out of 10 in the final exam to pass the subject, as well as a minimum of 3.0 out of 10 in each of its 2 parts.

❖ PERSONAL WORK AND GUIDED ACTIVITIES: 30%

A set of model problems will be proposed for each of the parts of the subject, which must be delivered before discussion and resolution in the seminar classes. These problems will be delivered, through the Virtual Campus, in Matlab Live Scripts. The use of the English language in solving these problems will be evaluated. In addition, each student must develop work throughout the course (personalized or in a team), whose evolution will be contrasted in the guided tutorials. This work will be presented in public, evaluating both the content and the student's ability to present it to their peers. Likewise, theoretical-practical training tests will be carried out for continuous evaluation during the tutorials, discussing the results to improve student learning (feedback). The evaluation will allow us to know the degree of achievement of the competencies CG1-MII4, CG6-MII6, CE10-B1, CE10-B2, CE10-B3, CE10-B4, CT2-II1, CT4-II1, CT5-II1, CT5-II2, CT10-II1, CT11-II1, CT13-II1. All this will represent 30% of the overall evaluation. For the extraordinary call, the qualification of personal work and directed activities will be maintained.

The final grade will result from the weighted average of the evaluable activities. However, to pass the subject it will be necessary to achieve the minimum grade established in each of them. If this requirement is not met, the final grade will be the weighted average obtained, with a maximum of 4.5 out of 10.

The grades of the activities planned for the evaluation of the subject (midterm exams, laboratories, tutorials, delivery of problems, etc.) will be communicated to the students sufficiently in advance before the final exam, so that they can adequately plan the study of this or other subjects.

In particular, the grades for the midterm exams will be communicated within a maximum period of 20 days, except in the case of the second midterm, in which the period may be shorter to adapt to the final exam. In any case, the minimum period of ten days will be

respected between the publication of the grades and the date of the final exam of the subject.

ACTIVITY SCHEDULE

UNIT	ACTIVITY	HOURS	GROUPS	START	END
1. Electrical Circuits	Lectures	14	1	1st Week	6th Week
	Seminars	4	1		
2. Electrical Machines	Lectures	17	1	7th Week	13th Week
	Seminars	4	1		
3. Low Voltage Electrotechnical Regulations	Lectures	2	1	14th Week	14th Week
	Seminars	1	1		
4. Automatic	Lectures	2	1	15th Week	15th Week
	Seminars	1	1		
	Tutorial*	4	1	Weeks 5, 8, 10 and 13	

*Scheduled tutorials are subject to possible modifications according to the joint planning of the course.

SUMMARY OF ACTIVITIES

TEACHING ACTIVITY	ASSOCIATED COMPETENCES	TEACHING ACTIVITY	STUDENT ACTIVITY	EVALUATION	P	NP	TOTAL	C
Lectures	CG1-MII4, CE10-B1, CE10-B2, CE10-B3, CE10-B4	Verbal presentation of the main lines of each topic of the programme.	Attention and active participation in the development of the class.	Written exams.	35	60	95	
Seminars	CG1-MII4, CG6-MII6, CE10-B1, CE10-B2, CE10-B3, CE10-B4, CT10-II1	Approach and resolution of numerical issues and problems.	Discussion and resolution of the proposed issues and problems. Oral presentation of personal or teamwork	Written exams and student participation in solving the proposed questions and problems. Delivery of problems and evaluation of oral presentations.	10	25	35	**30 %**
Tutorials/ Activities directed	CG1-MII4, CG6-MII6, CE10-B1, CE10-B2, CE10-B3, CE10-B4, CT2-II1, CT5-II1, CT5-II2, CT7-II1,CT10-II1, CT11-II1, CT13-II1	Monitoring students' progress in their personal work.	Development of your personal or teamwork	Assessment of the work carried out by the student in the development of the proposed personal or teamwork	4	6	10	
Exams	CG1-MII4, CE10-B1, CE10-B2, CE10-B3, CE10-B4, CT2-II1, CT5-II2, CT10-II1	Design and correction of the exam. Student qualification.	Carrying out the exam.	Exam	3	7	10	**70 %**

P: In-class activities

NP: Non-classroom activities (self-study)

C: Assessment weighting