Electrical power engineering fundamentals

Academic Year: (2019 / 2020) **Review date: 12-07-2019**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: MARTINEZ CRESPO, JORGE

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Students should have completed their first year. Special stress should be put into Calculus I and II, Linear Algebra and Physics Complements.

OBJECTIVES

After the student has passed this subject, he/she will be able to:
- Describe the basic aspects of the structure and operation of electric circuits and power systems (single- and three-phase), employing a proper wording and terminology, in terms of their fundamental variables: voltages, currents, power, impedances, and power factor.
- Analyze whatever electrical circuit in steady-state, calculating voltages, currents and power in each element, using systematic methods (nodal analysis, mesh analysis) as well as non-systematic ones (circuit reduction, grouping of elements, etc). Also he/she will be able to describe the behaviour of any dipole by substituting the balance of the circuit by its Thévenin or Norton equivalent.
- Perform this type of analysis on any a.c. circuit at constant frequency, representing the corresponding magnitudes by their associate complex phasors.
- Correctly choose and operate electrical instruments to carry out experimental measurements on a real circuit.
- Use the single-phase equivalent to analyze a simple balanced three-phase circuit, and correctly apply reactive power compensation techniques by insertion of banks of capacitors.
- Describe, justify, and explain the rationale underlying the structure and operation of the electric power systems, and the role of transformers and electrical machines.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
1.1. The electric system
1.2. General concepts
1.3. Kirchhoff's Laws
2. Direct current
2.1. Resistance and generators
2.2. Series and parallel associations
2.3. Mesh and node analysis
2.4. Theorems (Superposition, Thévenin and Norton)
3. Alternating Current
3.1. Coils and capacitors. Transients.
3.2. Waves and phasors
3.3. Impedance and admitance
3.4. Solving circuits in the frequency domain
3.5. Power in alternating current
4. Balanced three-phase circuits
4.1. General concepts
4.2. Phase and line magnitudes
4.3. Single-phase equivalent
4.4. Three-phase power and reactive power compensation
5. Analysis of first-order transient circuits

LEARNING ACTIVITIES AND METHODOLOGY

This subject has a twofold objective. On one side, the spreading of a basic electrical engineering culture, including the proper use of the technical language and vocabulary used to describe electric circuits and systems. On the other hand, the explanation of theoretical foundations and practical methods of analyzing linear, lumped-parameters, dc and ac circuits.

Therefore, the methodology is a mix of theoretical lectures, that essentially involve a thorough and systematic application of Kirchhoff's laws, and practical, problem solving oriented activities. Simple problems will be solved manually, more complex ones will require the use of computer tools.

During the development of this course the instructor could offer the students the possibility of doing a small personal work about a generic electric power system, using some free software package as tool. Originality, quality of gathered data, references, good writing and presentation will be assessed.

Classroom activities will be completed with three lab sessions, with a duration 100 minutes each one, on measurements and safety rules, dc circuits, ac circuits and 3-phase circuits, respectively.

ASSESSMENT SYSTEM

Student assessment can be done by any of two alternative methods: continuous evaluation+final exam or final exam only.

CONTINUOUS EVALUATION+FINAL EXAM:

- Continuous evaluation qualification will amount the 45% of the total. During the course, several exams involving numerical solving of sample problems will be proposed. These exercises will be worked during the first half of the session, and solved and commented by the instructor during the second half, comparing alternative strategies and fixing the most important/frequent errors. The average grade of these exams will amount 90% of the continuous evaluation qualification and can be complemented with proposed exercises and class work. The additional 10% will correspond the performance during the lab sessions. The attendance to these lab sessions is mandatory for all the students.

- The final exam (55% of the total grade), will consist in solving 3 - 4 numerical problems of circuit analysis, covering the whole content of the course (this part sums 50% of the total), plus a short test on the activities carried out during the lab sessions (remaining 5%).

The teacher can exempt any student from the final examination as long as they have made all intermediate exercises with a minimum grade of 2,5 points in every of them, and have an average continuous evaluation grade equal/greater than 5 points (not including the laboratory grade). The students accomplishing these conditions and wanting to improve their grades can do the final exam considering the the grade will be weighted with the continuous evaluation one.

The same criteria as above will apply in the extraordinary call, excluding the mention to the possibility of direct passing by course average grades.

FINAL EXAM ONLY:

a) Ordinary call
- 60 % of the total record will come from a final exam consisting in solving 3 - 4 numerical problems of circuit analysis, covering the whole content of the course (this amounts to 50% of the total), plus a short test on the activities carried out during the lab sessions (remaining 10%).

b) Extraordinary call
- 100 % of the total record will come from a final exam consisting in solving 3 - 4 numerical problems of circuit analysis, covering the whole content of the course (this amounts to 90% of the total), plus a short test on the activities carried out during the lab sessions (remaining 10%).

% end-of-term-examination:	55
% of continuous assessment (assigments, laboratory, practicals…):	45

BASIC BIBLIOGRAPHY

- Bruce A. Carlson Teoría de Circuitos, Thomson, 2002

- Guillermo Robles Muñoz Problemas resueltos de fundamentos de ingeniería eléctrica, Paraninfo, 2015
- J. Fraile Mora Electromagnetismo y Circuitos Eléctricos, McGraw Hill, 2005
- Julio Usaola & Mª Angeles Moreno Circuitos Eléctricos. Problemas y ejercicios resueltos, Prentice Hall, 2002

ADDITIONAL BIBLIOGRAPHY

- A. Conejo Navarro Circuitos eléctricos para la Ingeniería, McGraw-Hill, 2004
- A. Gómez Expósito Fundamentos de Teoría de Circuitos, Thomson, 2007
- A. Gómez Expósito Teoría de Circuitos. Ejercicios de autoevaluación, Thomson, 2005
- F. Barrero González Sistemas de Energía Eléctrica, Thomson, 2004