Magnetic circuits and transformers

Academic Year: (2023 / 2024) **Review date: 26/04/2023 10:26:53**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: GARCIA DE BURGOS, MARIA BELEN

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Physics II
Electrical Power Engineering Fundamentals

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
COCIN1. Ability to draft, sign and develop projects in the area of industrial engineering for construction, renovation, repair, preservation, demolition, manufacture, installation, assembly or operation of: structures, mechanical equipment, energy installations, electrical and electronic installations, industrial plants and installations and automation and manufacturing processes.
COCIN4. Ability to resolve problems with initiative, decision-making, creativity, and critical reasoning skills and to communicate and transmit knowledge, skills and abilities in the Industrial Engineering field.
COCIN5. Knowledge to perform measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar jobs.
COCIN6. Ability to deal with mandatory specifications, regulations and norms.
CEP1. Capacity to design a system, component or process in the area of electrical engineering in compliance with required specifications.
CEP2. Knowledge and ability to apply computational and experimental tools for analysis and quantification of electrical engineering problems.
CEP3. Ability to design and carry out experiments to analyze and interpret data obtained.
CEB2. Understanding and command of the fundamental concepts of the general laws of mechanics, thermodynamics, electromagnetic fields and waves and application for resolving engineering problems.
CER4. Knowledge and use of the principles of electrical circuits and electric machinery theory.
ECRT1. Capacity for calculation and design of electric machinery.

By the end of this content area, students will be able to have:
RA1.3. Coherent knowledge of the branch of electrical engineering including some at the forefront of their branch in electric machines.
RA2.1. The ability to apply their knowledge and understanding to analyse engineering products, processes and methods.
RA2.3. The ability to select and apply relevant analytic and modelling methods in electric machines and drives.
RA3.1. The ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements.
RA3.2. An understanding of design methodologies for electric power conversion, and an ability to use them.
RA4.2. The ability to design and conduct appropriate experiments, interpret the data and draw conclusions.
RA4.3. Workshop and laboratory skills.
RA5.1. The ability to select and use appropriate equipment, tools and methods for electric machines

and drives.
RA5.2. The ability to combine theory and practice to solve electrical engineering problems.
RA5.3. An understanding of applicable techniques and methods in the design, analysis and selection of electric machines and drives, and of their limitations.
RA6.3. Demonstrate awareness of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of engineering practice.

OBJECTIVES

Skills to design electromagnetic devices. Skills to analyze the performance of a transformer under different circumstances. Skill to carry out tests to obtain transformer parameters. Basic knowledge about national and international standards. Skill to analyze interactions between the transformer and the electrical system. Skill to select a transformer for a given aplication.

Explain and justify the working principle of single-phase transformers, three-phase transformers and instrument transformers and their function in power systems.

DESCRIPTION OF CONTENTS: PROGRAMME

Topic 1: REVIEWING BASIC CONCEPTS ON ELECTRICITY AND MAGNETISM. Maxwell's equations. Core losses. Dielectric losses. Magnetic circuits. Self and mutual inductances.
Topic 2: CONSTITUTION OF POWER TRANSFORMERS. Magnetic core, windings, insulation system. Transformer refrigeration. Basic concepts on maintenance.
Topic 3: SINGLE-PHASE TRANSFORMERS. No load performance. On-load performance. Overloads. Equivalent circuit. Efficiency. Voltage drop. Parallel operation. Short circuit currents. Inrush current.
Topic 4: THREE-PHASE TRANSFORMERS. Types of transformers. Phasor groups. No-load performance. Transformer performance under balanced and un-balanced loads. Zero-sequence impedance. Tertiary windings. Interconnected star windings. Three winding transformers. Autotransformers. Tap changers. Application of the different transformer types and phasor groups.

LEARNING ACTIVITIES AND METHODOLOGY

The learning methodology includes:
- Lectures covering the main topics described within the course outline.
- Case study and problem solving lectures, where some issues are addressed from a practical point of view.
- Laboratory sessions

ASSESSMENT SYSTEM

% end-of-term-examination/test:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

At least two partial exams which include problems and theory questions. With a score upper than 5.0 the exercise is passed.
Those students with one or various failed exercised must perform a final exam of those failed exercises.
The laboratory weight is 10% of the final grade. At the end of the course the students will take a test on the lab sessions.

BASIC BIBLIOGRAPHY

- Kulkarni, S.V; Khaparde, S.A. Transformer engineering. Design and Practice, Marcel Dekker, 2012

ADDITIONAL BIBLIOGRAPHY

- S.Kulkarni; S Khaparde Transformer Engineering. Design and Practice, Marcel Dekker, 2012

BASIC ELECTRONIC RESOURCES

- Juan Carlos Burgos . OCW Circuitos Magnéticos y Transformadores: http://ocw.uc3m.es/ingenieria-electrica/circuitos-magneticos-y-transformadores