Electric power generation

Academic Year: (2023 / 2024) **Review date: 07-06-2023**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: SANTOS MARTIN, DAVID

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

All first and second year subjects. Among them, Electrical Power Engineering Fundamentals is of utmost importance.

SKILLS AND 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.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CG2. Apply computational and experimental tools for analysis and quantification of energy engineering problems
CG4. Being able to do design, analysis, calculation, manufacture, test, verification, diagnosis and maintenance of energetic systems and devices.
CG10. Being able to work in a multi-lingual and multidisciplinary environment
CE11 Módulo CRI. Knowledge and use of the basic principles of electrical circuits and electric machinery theory.
CE4 Módulo TE. Ability for the calculus and design of electric machines.
CE5 Módulo TE. Ability for the design of electric power plants.
CE13 Módulo TE. Understanding the relation between the different variables seizing in the operation of electric power systems and the electric energy demand coverage.
CT1. Ability to communicate knowledge orally as well as in writing to a specialized and non-specialized public.
CT2. Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3. Ability to organize and plan work, making appropriate decisions based on available information, gathering and interpreting relevant data to make sound judgement within the study area.
CT4. Motivation and ability to commit to lifelong autonomous learning to enable graduates to adapt to any new situation.

By the end of this content area, students will be able to have:
RA1.2 a systematic understanding of the key aspects and concepts of electric power generation.
RA2.1 the ability to apply their knowledge and understanding to identify, formulate and solve calculation, design and tests electric generation systems problems using established methods.
RA2.3 the ability to select and apply relevant analytic and modelling methods for calculation, design and test of electric power generation components.
RA3.1 the ability to apply their knowledge and understanding to develop and realise designs of electric power generation systems and components meeting defined and specified requirements.
RA4.2 the ability to design and conduct appropriate experiments for the characterization of electric power generation systems, interpret the data and draw conclusions.
RA5.2 the ability to combine theory and practice to solve engineering problems of electric power generators.
RA6.1 function effectively as an individual and as a member of a team.

OBJECTIVES

Students who successfully complete this course will develop the:

- Ability to perform calculations on machines using electrical circuit theories.

- Ability to explain both, the theory of electric generation in conventional power plants, and wind turbines.

- Ability to understand both, the impact of the different electric power generation plants into the grid, and the control capabilities to mitigate it.

- Capacity to work in a team and promote creative team interaction to encourage contribution from all members.

DESCRIPTION OF CONTENTS: PROGRAMME

1 Introduction to electric power generation
- Sources of energy
- Energy conversion systems
- Power generation statistics
- Generation-transmission-distribution
- Control and operation of the electric system

2 Electrical energy conversion systems

2.1 Transformers
- Introduction: why Transformers are so important?
- Types and construction of transformers
- The ideal transformer
- The equivalent circuit of a real single-phase transformer
- Transformer taps, voltage regulation and efficiency
- Three-phase transformers
- The per-unit system

2.2 Electric machinery fundamentals
- Introduction
- Basic components
- Understanding magnetic circuits and the rotating machines laws

2.3 Synchronous generator
- Introduction to synchronous machines
- Excitation systems
- Principle of operation of synchronous machines
- Equivalent electric circuit of the non-salient pole synchronous generator
- Generated power
- Capability limits

2.4 Asynchronous generator
- Introduction to asynchronous machines
- Induction generator:
    - Equivalent electric circuit
    - Power flow model
    - Tests to identify the machine parameter values
    - Torque-speed characteristic curve
    - Starting methods
    - Speed regulation
- Doubly fed induction generator:
    - Equivalent electric circuit
    - Power flow model
    - Torque-speed characteristic curve
    - Speed regulation

LEARNING ACTIVITIES AND METHODOLOGY

The learning methodology consists of:

- lectures covering the most important topics defined in the course programme.

- simple problem solving sessions focused on practical situations.

- 3 laboratory sessions covering the main systems.

ASSESSMENT SYSTEM

ORDINARY CALL (C1): CONTINUOUS EVALUATION (E1) and FINAL EXAM (E2):

- (E1) Continuous evaluation (45% of the total)

It will be calculated as the mean value of two partial assessments taking place during the lectures, typically taking place around midterm and the end of the term. They will consist in solving numerical problems and theory questions covering the whole content of the course.

- (E2) Final exam (55% of the total grade)
It will consist in solving numerical problems and theory related questions covering the whole content of the course.

C1=0.45*E1+0.55*E2

Note: to be eligeble to pass by the ordinary call (C1) it is mandatory to attend to all the laboratory sessions and have followed at least 10 problem sessions, solving all the problems at the end of the class. Furthermore E2 has to be greater or equal to 3.0/10.

EXTRAORDINARY CALL (C2)

- 100 % of the total record will come from a final exam (E3) that will consist in solving numerical problems and test questions covering the whole content of the course.

C2=E3

Note: to be eligeble to pass by the extraordinay call (C2) it is mandatory to attend to all the laboratory sessions.

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

BASIC BIBLIOGRAPHY

- Fitzgerald & Kingsley's Electric Machinery 7TH EDITION, McGraw-Hill, 2014
- Math H. Bollen, Fainan Hassan Integration of Distributed Generation in the Power System, Wiley, 2011
- Remus Teodorescu, Marco Liserre, Pedro Rodriguez Grid Converters for Photovoltaic and Wind Power Systems, Wiley, 2011
- Stephen .J Chapman Electric Machinery Fundamentals, 5ª ed, McGraw-Hill, 2011

ADDITIONAL BIBLIOGRAPHY

- Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheble Power Generation, Operation and Control, 3rd Edition, Wiley, 2013
- Gonzalo Abad, Jesus Lopez, Miguel Rodriguez, Luis Marroyo, Grzegorz Iwanski Doubly Fed Induction Machine: Modeling and Control for Wind Energy Generation, Wiley-IEEE Press, 2011