Alternating current electrical machines

Academic Year: (2023 / 2024) **Review date: 28-03-2023**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: BURGOS DIAZ, JUAN CARLOS

Type: Electives ECTS Credits : 6.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Electric power engineering fundamentals (2nd year),
Magnetic Circuits and Power Transformers (3rd year)

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.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.
RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

OBJECTIVES

After having passed this subject, the student will be able to:
- Describe the operating principle and physical constitution of the different types of rotating electrical machiones used in industrial facilities
- Compute the numerical parameters of their equivalent circuits from standard tests
- Use the equivalent circuit to obtain quantitative and qualitative conclusions about the behaviour of ac

rotating electrical machines under real operating conditions
- Define the safe operational limits of electrical machines
- Select and define the set of specificacions of any electrical rotating ac machine for each individual applications, from technical datasheets
- Justify the interactions of these machines with the balance of the electrical power system.

DESCRIPTION OF CONTENTS: PROGRAMME

1. General aspects of rotating electrical machines
1.1 Introduction.
1.2 Technologial aspects: degrees of protection, isolation, definition of rated power, heating and service classes.
1.3 Constructive aspects: Description of the various components of electrical machines.
1.4 Basic concepts of electromaghnetism: magnetic fields and electromotive forces applied to electrical machines

2. Induction machines
2.1 Introduction. Constructive aspects and fundamentals.
2.2 Equivalent circuit. Description of the equivalent circuit of an asynchronous machine in steady state.
2.3 Power balance. Description of the balance of active and reactive power. Internal mechanical power and torque.
2.4 Mechanical characteristics. Deduction of the speed-torque curve and calculation of performance.
2.5 Standard tests on induction motors. No-load and short-circuit tests.
2.6 Starting methods. Direct-on-line, trnasformer, wye/delta, rotor resistances, electronic starters
2.7 Speed variation. Traditional methods of variation of speed and braking methods.
2.8. Braking of induction motors. Free braking. Braking time. D.C. braking. Frequency ramp. Voltage ramp.
2.8 Asynchronous generator. Description of the machine in generator mode and applications.

3 Synchronous machines.
3.1 Introduction. Physical constitution, cooling systems and excitation systems.
3.2 Principle of operation.
3.3 No-load and load operation. Armature reaction.
3.4 Equivalent circuit of a synchronous machine in saturated and unsaturated condition. Synchronpus impedance.
3.5 Standard tests: no-load, short-circuit and pure reactive load.
3.6 Calculation of the equivalent circuit parameters. Absolute and relative values. Short circuit ratio.
3.7 Determination of the excitation values in load mode.
3.8 Coupling to an infinete bus. Synchronization. Control of active and reactive power.
3.9 Stability limits in steady state.
3.10 Short-circuit current. Concept of subtransient and transient reactance.
3.11 Operational limits. Obtaining the operational limits chart in generator- and motor region.
3.12 Salient pole synchronous machines.
3.13 Motor operation, application and starting methods.

LEARNING ACTIVITIES AND METHODOLOGY

1. TRAINING ACTIVITIES
1.1 Class lectures and numerical exercises in small groups, tutoring and student personal work; aimed at the acquisition of theoretical knowledge.
1.2 Laboratory sessions and computer simulation sessions, individual tutorials and student's personal work, oriented to the acquisition of practical and problem-solving skills related to the content of this subject.
1.3 The students will carry out a miniproject about selecting the elements of a facility involving an electrical machine (starter, speed control and braking selection), in teams of up to three students.

2 TUTORIALS:
2.1 Individual tutorials: the schedule will be published at the beginning of the course.

ASSESSMENT SYSTEM

The calification of the subject is the weighted average of three activities:

1) Written exams (65% of the grade of the subject)
2) Sizing work (26% of the grade of the subject)

3) Laboratory practices (9% of the grade of the subject)

Written exams include theoretical questions (19%) and problems (46%). During the course intermediate exams will be carried out that allow to elimitate parts from the final exam of the subject.

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

BASIC BIBLIOGRAPHY

- Vicent del Toro Basic Electric Machines, Prentice Hall, 1990