Alternating current electrical machines

Academic Year: (2022 / 2023) **Review date: 24/05/2021 14:27:48**

Department assigned to the subject:

Coordinating teacher:

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Electric power engineering fundamentals (2nd year), Circuitos magnéticos y transformadores (4th year)

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 Synchronous machines.
2.1 Introduction. Physical constitution, cooling systems and excitation systems.
2.2 Principle of operation.
2.3 No-load and load operation. Armature reaction.
2.4 Equivalent circuit of a synchronous machine in saturated and unsaturated condition. Synchronpus impedance.
2.5 Standard tests: no-load, short-circuit and pure reactive load.
2.6 Calculation of the equivalent circuit parameters. Absolute and relative values. Short circuit ratio.
2.7 Determination of the excitation values in load mode.
2.8 Coupling to an infinete bus. Synchronization. Control of active and reactive power.
2.9 Stability limits in steady state.
2.10 Short-circuit current. Concept of subtransient and transient reactance.
2.11 Operational limits. Obtaining the operational limits chart in generator- and motor region.
2.12 Salient pole synchronous machines.
2.13 Motor operation, application and starting methods.

3. Asynchronous machine
3.1 Introduction. Constructive aspects and fundamentals.

3.2 Equivalent circuit. Description of the equivalent circuit of an asynchronous machine in steady state.
3.3 Power balance. Description of the balance of active and reactive power. Internal mechanical power and torque.
3.4 Mechanical characteristics. Deduction of the speed-torque curve and calculation of performance.
3.5 Standard tests on induction motors. No-load and short-circuit tests.
3.6 Starting methods. Direct-on-line, trnasformer, wye/delta, rotor resistances, electronic starters
3.7 Speed variation. Traditional methods of variation of speed and braking methods.
3.7 Asynchronous generator. Description of the machine in generator mode and applications.
3.8 Single phase ac motors. Description of single phase and Leblanc theorem.

4. Speed regulation of ac electrical machines.
4.1 Elements of a variable-frequency drive system.
4.2 Generation of PWM sinusoidal waves.
4.3 The equivalent circuit of the induction motor at variable frequency.
4.4 Scalar control. Constant flux (torque) range and variable flux (constant power) range.
4.5 Technological and practivcal aspects of variable speed drives.

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, braking), 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

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

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

1) Written exams (75% of the grade of the subject)
2) Sizing work (25% of the grade of the subject)

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

Intermediate exams consist of three exercices:
Asynchronous machines (25% of intermediate calification)
Supervised work of asynchronous machines (25% of intermediate calification)
Synchronous machines (50% of intermediate calification)

BASIC BIBLIOGRAPHY

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