Principles of electric energy conversion

Academic Year: (2019 / 2020) **Review date: 26/04/2017 14:40:06**

Department assigned to the subject:

Coordinating teacher: SANZ FEITO, JAVIER

Type: Electives ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Fundamentals of Electrical Engineering (2nd year), Electric Technolgy (3rd year)

It is highly advisable to take this course along with the elective course "Rotating Electrical Machines" that is offered during the same year and semester, where emphasis is put on practical aspects and applications of electrical machines.

OBJECTIVES

At the end of the course, students should have a first insight on the structure and basic operation of the four main types of electromagnetic energy converters, from the fundamentals of magnetic circuits to the general description of rotating energy converters.

The course content is centered on the description and theoretical aspects which constitute the basis of the operation of electrical machines and transformers. As a result, the student should be able to explain and justify the operating behaviour of the different types of electrical machines by means of their equivalent circuits, compute their expected performance, and describe the basic aspects of its design and sizing.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Magnetic circuits.
1.1 Fundamentals of magnetic circuits; magnetomotive force, reluctance, permeance.
1.2 Mutual- and stray flux.
1.3 Magnetic circuits with permanent magnets.

2. Power transformers.
2.1 Physical construction.
2.2 Cooling methods.
2.3 No-load and on-load operation.
2.4 Equivalent circuit. Standard tests.
2.5 Voltage drop and efficiency.
2.6 Short-circuit current.
2.7 Three-phase transformers. Vector groups.
2.8 Autotransformers. On-load tap changers.

3. The DC machine.
3.1 General arrangement and basic operation.
3.2 The emf equation and torque development.
3.3 Power balance.
3.4 Performance of separately excited DC motors. Mechanical characteristics and speed regulation.

4. Magnetic fields in AC machines.
4.1 The ideal electrical machine: analysis of magnetic fields in the air gap
4.2 Distribution and pitch factor. Winding factor.
4.3 Rotating magnetic fields: Ferraris's theorem.

4.4 Transfomer- and rotating emf forces.
4.5 Torque creation.
4.6 Utilization (Esson's) factor and rotor volume.

5. AC induction machines.
5.1 Building aspects and operating principle.
5.2 Equivalent circuits.
5.3 Power balance.
5.4 Torque equation.
5.5 Mechanical output characteristic.
5.6 Efficiency.
5.7 Standard tests.

6. AC synchronous machines.
6.1 Building issues and operating principle.
6.2 No load operation. Load operation: armature reaction.
6.3 Equivalent circuit. Synchronous impedance. Saturation. Linearisation.
6.4 Standard test: no load, short circuit and pure reactive load characteristics.
6.5 The AC generator connected to an infinite bus. Synchronisation
6.6 Active- and reactive power regulation.
6.7 Operating limits chart.
6.7 Synchronous motor operation.

LEARNING ACTIVITIES AND METHODOLOGY

Due to the elective nature of this course and the small number of students that are expected to take it, theoretical lectures and practical sessions will be closely interleaved. Some sessions will be developped in the electrical machines laboratory, where the instructor will perform practical demonstrations of machines operation to support theoretical explanations. Students will eventually have the opportunity to participate in these demonstrations under the teacher supervision.

Student will be encouraged and are expected to have an active role and a proactive attitude in the developmment of sessions, by means of homeworks, problem-solving activities and open group debates. In parallel, individual tutorial sessions will be offered.

ASSESSMENT SYSTEM

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

The course assessment is based both on continuous assessment and final exam. Continuous assessment includes the mandatory attendance to all classes, and the delivery of numerical exercises and homeworks proposed during the course. The final exam will include the numerical solution of two to three problems and the answers to a set of short questions about the most relevant theoretical concepts.

BASIC BIBLIOGRAPHY

- DEL TORO, V. Basic Electric Machines, Prentice Hall, 1990

- FARILE MORA, J Máquinas Eléctricas, McGraw Hill, 6ª edición, 2008

- FITZGERALD, A.E. KINGSLEY, CH., UMANS, S.D. Máquinas Eléctricas, Ed. McGraw-Hill, 5ª ed., 1992

- SANZ FEITO, J Máquinas Eléctricas, Prentice Hall, 2002