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|------------------|--------------------------------------|----------------|---------------------------------------|
| Course Unit      | Electrical Machines                  | Field of study | Energy Systems                        |
| Bachelor in      | Electrical and Computers Engineering | School         | School of Technology and Management   |
| Academic Year    | 2023/2024                            | Year of study  | 2                                     |
| Type             | Semestral                            | Semester       | 2                                     |
| Workload (hours) | 162                                  | Contact hours  | T 30 TP - PL 30 TC - S - E - OT - O - |
| Level            | 1-2                                  | ECTS credits   | 6.0                                   |
| Code             | 9112-742-2203-00-23                  |                |                                       |

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) **Ângela Paula Barbosa da Silva Ferreira**

### Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. understand the theory of operation and modelling of electric transformers;
2. describe the operation and applications of autotransformers and instrument transformers;
3. understand the theory of operation and modelling of single and three-phase induction machines;

### Prerequisites

Before the course unit the learner is expected to be able to:

1. understand the quasi-stationary approximation for the Maxwell's equations;
2. use vector calculus and complex numbers;
3. analyse single and three-phase AC electric circuits.

### Course contents

Static and rotating electric machines: transformers and induction machines.

### Course contents (extended version)

1. Introduction to machinery principles
  - Electric circuits, magnetic circuits and mechanical parts
  - Rated quantities and load regimes
  - Losses and efficiency
  - Codes and standards
  - Rotating magnetic field concept
2. Single and three-phase transformers
  - Construction features
  - Theory of operation
  - Modeling and experimental tests to determine the parameters
  - Voltage regulation and efficiency
  - Three-phase units and transformer banks; three-phase transformation using two transformers
3. Special transformers
  - Autotransformers
  - Instrument transformers
4. Three-phase induction machines
  - Construction features and theory of operation
  - Modeling and experimental tests to determine the parameters in the machine model
  - Power and torque
  - Torque-speed characteristics (motor, generator and braking modes)
  - Starting and stability of the three-phase induction motor
  - Speed control of induction motors
  - Doubly fed induction generator
5. Single-phase induction machines
  - Construction features and theory of operation
  - Major characteristics and applications

### Recommended reading

1. S. J. Chapman, *Electric Machinery Fundamentals*, 5th Ed. , McGraw Hill, 2011.
2. S. L. Herman, *Electrical Transformers and Rotating Machines*, 4th Ed. , Cengage Learning, 2016.
3. J. F. Gieras, *Electrical Machines, Fundamentals of Electromechanical Energy Conversion*, CRC Press, 2020.
4. I. Boldea, *Reluctance Synchronous Machines and Drives*, Oxford University Press, 1996.

### Teaching and learning methods

Theoretical classes: presentation of the course contents. Practical and laboratory classes: problem solving to support the expected learning outcomes and laboratory experiments to realize in practice some issues treated analytically.

### Assessment methods

1. Distributed assessment - (Regular, Student Worker) (Final, Supplementary)
  - Laboratory Work - 40%
  - Final Written Exam - 60% (It is required a minimum classification of 25%.)
2. Global assessment - (Regular, Student Worker) (Final, Supplementary, Special)
  - Final Written Exam - 100%

### Language of instruction

Portuguese, with additional English support for foreign students.

## Electronic validation

|  |  |                                   |                          |
|--|--|-----------------------------------|--------------------------|
| Ângela Paula Barbosa da Silva Ferreira | José Augusto de Almeida Pinheiro<br>Carvalho | José Luís Sousa de Magalhaes Lima | José Carlos Rufino Amaro |
| 29-02-2024                             | 02-03-2024                                   | 06-03-2024                        | 09-03-2024               |