

Course Unit	Electrical Machines		Field of study	Energy Systems	
Bachelor in	Electrical and Computers Engineering		School	School of Technology and Management	
Academic Year	2021/2022	Year of study	2	Level	1-2
Type	Semestral	Semester	2	ECTS credits	6.0
Code			9112-742-2203-00-21		
Workload (hours)	162	Contact hours	T	30	TP
			PL	30	TC
			S	-	E
			OT	-	O

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;
4. understand the theory of operation and modeling of conventional synchronous machines (wound rotor, salient and non-salient poles), permanent magnet machines and reluctance 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 electrical systems.

Course contents

Transformers, induction machines, wound synchronous machines (salient and non salient poles), permanent magnet machines and reluctance 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
6. Synchronous machines
 - Construction features and theory of operation
 - Armature reaction
 - Steady-state characteristics
 - Modeling and experimental tests to determine the parameters in the machine model
 - Exciters
 - Synchronous generator operating alone
 - Starting synchronous motors
7. Permanent magnet and reluctance machines
 - Construction features and theory of operation
 - Trends in machinery design

Recommended reading

1. Electric Machinery Fundamentals, S. J. Chapman, 5th Ed., McGraw Hill, 2011
2. Electrical Transformers and Rotating Machines, S. L. Herman, 4th Ed., Cengage Learning, 2016
3. Electric Machines and Power Systems, Volume 1 - Electric Machines, S. A. Nasar, McGraw Hill, 1995
4. Permanent Magnet Motor Technology, J. F. Gieras, M. Wing, 2.ª Edição, Marcel Dekker, 2002
5. Reluctance Synchronous Machines and Drives, I. Boldec, 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

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01-03-2022	02-03-2022	21-03-2022	22-03-2022