UCLouvain

lelec1310

2023

ELECTROMECHANICAL CONVERTERS

5.00 credits	30.0 h + 30.0 h	Q2

Teacher(s)	Dehez Bruno ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	- LEPL 1202 (Physics) - LELEC 1370 (Measurements and electrical circuits) *The prerequisite(s) for this Teaching Unit (Unité d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.*
Main themes	- Single-phase and three-phase transformers - General Theory of electromechanical converters - Rotating field machines - Asynchronous machines - Synchronous machines - DC Machines
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 In consideration of the reference table AA of the program " Master's degree civil engineer mechanics ", this course contributes to the development, to the acquisition and to the evaluation of the following experiences of learning: **Contribution of the course to the program objectives** Axis 1 (1.1, 1.2, 1.3), Axis 3 (3.3), Axis 5 (5.4) **Specific learning outcomes of the course** At the end of the course, students will be able to: - Link the fundamental concepts (Faraday's law, energy and magnetic co-energy, ...) to the general equations of an electromechanical converter; - Build the steady state model (equations and equivalent circuit) of a rotating field machine, an asynchronous machine (three or single-phase), a synchronous machine and a DC machine; - Build the steady state model (equations and equivalent circuit) of the transformer (single or three phase); - Experimentally determine the parameters of these models - Use these models to predict operating conditions of these devices depending on the supply and the load. In addition, the student will be able to: - Determine and interpret the characteristic quantities of an electromechanical converter or transformer; - Identify the main electromechanical converters structures; - Establish the conditions guaranteeing the energy conversion in an electromechanical converter; - Explain the principle of the universal motor; - Explain the ways to increase the starting torque, to reduce the starting current or to vary the speed of an electromechanical converter; - Explain how to connect and control an alternator on the grid.

Evaluation methods	Students will be evaluated: • Collectively based on the reports of the 2 practical labs performed in groups of 4 to 5 students during the semester; • Individually based on a written exam for the exercise part of the course and an oral exam for the theoretical part. For the written exam, no documents are allowed except a form of two A4 pages written by the student and containing only formulas, diagrams or graphs. The final mark is the weighted average of the marks obtained for : • The reports on the two laboratories, 20%; • The written examination on the exercises, 40%; • The oral examination on the theory, 40%. The marks for the laboratory reports are only acquired in case of attendance/participation to the laboratories. They are also acquired in the first session and kept in case of a second session. The use of generative AI software such as chatGPT is permitted only for assistance in writing of the reports requested in this course. In this instance, however, an appendix will be required detailing, for each of the sections concerned, how the AI was used (information search, drafting and/or correction of the text, ...). Furthermore, external sources of information must be systematically cited in compliance with bibliographic referencing standards.
Teaching methods	Teaching is organized in: • 13 lectures; • 7 supervised exercise sessions; • 2 practical lab sessions; • 3 virtual lab sessions. The practical lab sessions are carried out in groups of 4 or 5 students and lead to the writing of a synthesis report. Virtual lab sessions are carried out autonomously online (via iCampus), but consultancy session are nevertheless organized. The Moodle platform also includes a series of multiple-choice questions allowing the students to evaluate and deepen their understanding of key concepts for the course. It also includes a series of illustrations for better appropriating these concepts. Depending on the health situation, the teaching activities can be organized in face-to-face, remotly, using videoconference, or a mix of both.
Content	Electromechanical converters convert electrical energy into mechanical energy, and vice versa. They play a crucial role in many fields, such as energy production or electric mobility, and are therefore a key link in the energy transition. In this context, understanding how these converters work and how their operating conditions impact their behavior and energy performance are the general objectives of this course. More specifically, it covers the following content: - Single-phase transformers: basic concepts of single-phase circuits; function and purpose, structures; fundamental laws; models of the ideal transformer, the perfect transformer and the real transformer; on-load operation; energy efficiency; constructive aspects; identification of parameters - Three-phase transformers: basic concepts of three-phase circuits; construction; connection modes; single-phase equivalent circuit; parameter identification - General theory of electromechanical converters: classification of converters; structure; basic assumptions; electrical equations; magnetic energy and co-energy; electromagnetic torque - Rotating-field machines: structure; rotating field; equations; power supply, phase notation; equivalent circuit; impact of saturation; operation in synchronous and asynchronous machines; other rotating-field machine structures - The three-phase asynchronous machine: operating conditions; special constructive arrangements; equations, equivalent circuit, phasor diagram (circle diagram); torque-speed characteristic; operating point; impact of magnetic materials; energy efficiency; operating problems (starting torque-current vs. efficiency, speed adjustment); special applications (phase shifter and induction regulator, electric axis - Selsyn, synchronoscope, Leblanc damper); parameter identification. - The single-phase asynchronous machine: structures; principle; equations - The synchronous machine: applications; special constructive arrangements; equations; equivalent diagrams; vector diagram; operating point (stability); energy efficiency; active and reactive power regulation; regulators associated with alternators; operation as a motor and as an isolated alternator; starting and synchronization on the grid; parameter identification - The commutator DC machine: special design features; basic structure; equations; linear commutation; operating and excitation modes; starting modes; energy efficiency; universal motor - The electronically commutated DC machine: basic structure; general principle
Inline resources	Moodle https://moodle.uclouvain.be/course/view.php?id=1893

Bibliography	- Transparents du cours - Enoncés et solutionnaires d'exercices - Notices de laboratoires et laboratoires virtuels - Illustrations et compléments au cours - QCM - Livre de référence : B. Dehez, D. Grenier, F. Labrique, E. Matagne, Electromécanique. Principes physiques, Principaux Convertisseurs, Principales applications, Presses universitaires de Louvain, 1er éd., 372p.
Faculty or entity in charge	ELEC

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Specialization track in Electricity	FILELEC	5		
Minor in Electricity	LMINOELEC	5		
Mineure Polytechnique	MINPOLY	5		