UCL Université catholique de Louvain

LELEC1310

2016-2017

ELECTROMECHANICAL CONVERTERS

5.0 credits	30.0 h + 30.0 h	2q

Teacher(s) :	Dehez Bruno ;
Language :	Français
Place of the course	Louvain-la-Neuve
Inline resources:	Moodle > http://moodleucl.uclouvain.be/course/view.php?id=8988
Prerequisites :	- LELEC 1350 (Applied electromagnetism) - LELEC 1370 (Measurements and electrical circuits) ou LELEC 1755 (Electricity complement) *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
Aims :	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. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
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 examination for the exercise part of the course and an oral examination for the theoretical part. For the written part of the examination, no documents are allowed except a form of two A4 pages written by the student and containing only formulas, diagrams or graphs.

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 iCampus 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.
Content :	- Introduction, reminder of the basics of electrical circuits (1h) - The single-phase transformers (4h): structure, fundamental laws, models of the ideal transformer, of the perfect transformer and of the real transformer, on load operation, experimental parameter identification - Three-phase transformers (1 hour): structure, connection modes, single-phase equivalent circuit - The general theory of electromechanical converters (2 hours): classification, structure, basic assumptions, electrical and mechanical equations, magnetic energy and co-energy, electromagnetic torque - Rotating field machines (4h): general design features, equations, supply, equivalent circuit, saturation, synchronous and asynchronous operating modes, main structures of rotating field machines - The three-phase asynchronous machine (5h): specific design features, equations, equivalent circuit, phasor diagram (the circle diagram), torque-speed characteristic, operating point, saturation, iron losses, power and efficiency, practical problems (current-starting torque vs efficiency, speed control), specific applications (phase shifter and induction regulator, electrical axis - Selsyn, synchronoscope, Leblanc damper) - The single-phase induction motor (1 hour): structure, principle and equations - The synchronous machine (4h): specific design features, equations, equivalent circuits, phasor diagram, operating point (stability), active and reactive power control, connection and control of an alternator on the grid - The DC machine (2h): specific design features, structure, equations, operating and excitation modes, starting, universal motor - Introduction, reminder of the basics of electrical circuits (1h) - The single-phase transformers (4h): structure, fundamental laws, models of the ideal transformer, of the perfect transformer and of the real transformer, on load operation, experimental parameter identification - Three-phase transformers (1 hour): structure, connection modes, single-phase equivalent circuit - The general theory of electromechanical converters (2 hours): classification, structure, basic assumptions, electrical and mechanical equations, magnetic energy and co-energy, electromagnetic torque - Rotating field machines (4h): general design features, equations, supply, equivalent circuit, saturation, synchronous and asynchronous operating modes, main structures of rotating field machines - The three-phase asynchronous machine (5h): specific design features, equations, equivalent circuit, phasor diagram (the circle diagram), torque-speed characteristic, operating point, saturation, iron losses, power and efficiency, practical problems (current-starting torque vs efficiency, speed control), specific applications (phase shifter and induction regulator, electrical axis - Selsyn, synchronoscope, Leblanc damper) - The single-phase induction motor (1 hour): structure, principle and equations - The synchronous machine (4h): specific design features, equations, equivalent circuits, phasor diagram, operating point (stability), active and reactive power control, connection and control of an alternator on the grid - The DC machine (2h): specific design features, structure, equations, operating and excitation modes, starting, universal motor
Bibliography :	- Lecture slides; - Exercises statements and solutions; - Laboratory notices; - Illustrations; - Multiple-choice questionnaires. - Reference Book: D. Grenier, F. Labrique, H. Buyse, E. Matagne, Electromechanics. Energy converters andactuators, Dunod, Paris, 2nd ed., 306P.
Other infos :	A question/answer session is organized at the end of the semester.
Faculty or entity in charge:	ELEC

Programmes / formations proposant cette unité d'enseignement (UE)				
Intitulé du programme	Sigle	Credits	Prerequis	Acquis d'apprentissage
Minor in Engineering Sciences: Electricity	LELEC100I	5	LELEC1370	