UCLouvain

lelec2313

2019

Dynamic modelling and control of electromechanical converters

In view of the health context linked to the spread of the coronavirus, the methods of organisation and evaluation of the learning units could be adapted in different situations; these possible new methods have been - or will be - communicated by the teachers to the students.

5 credits	30.0 h + 30.0 h	Q1

Teacher(s)	De Jaeger Emmanuel ;Dehez Bruno ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	• Dynamic models of DC machines • Dynamic models of synchronous machines • Dynamic models of asynchronous machines • Space phasors and variable transformations (Concordia, Park and Clarke) • Control of DC machines • Vector and scalar control of asynchronous machines • Vector control of synchronous machines
Aims	1 With respect to the AA referring system defined for the Master in Electrical Engineering, the course contributes to the develoopment, mastery and assessment of the following skills : • AA1.1, AA1.2, AA1.3 • AA3.3 • AA5.6 **Specific learning outcomes of the course** At the end of the course, the student will be able to : - Derive the dynamic model of electromechanical converters (DC and brushless DC machines, synchronous and asynchronous machines) in order to control them, in particular by exploiting the variable transformations (Concordia, Park and Clarke). - Describe the main control strategies of these converters (scalar V/f control of asynchronous machines, vector and direct torque control for asynchronous and synchronous machines) and choose them according to the application. - Use the adapted dynamic models in order to simulate the dynamic behaviour of these converters - Use the adapted dynamic models in order to synthesize type P, PI or PID controllers. - Use the adapted dynamic models in order to check the robustness and performance of a controller regarding modelling simplifications, external disturbances, changes in the machine parameters, ... - - - - *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	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** The final grade is based on: - the grades obtained for the homework reports done in groups during the semester, - the grade obtained for an oral exam (closed book) dealing with all the topics of the course.
Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Teaching is organized in the form of: - Lectures; - Homework on modelling and control of the various electromechanical converters seen during the lectures. The homework are performed in groups of 2 or 3 students and lead to a synthesis report, which is evaluated and is involved in the final evaluation of the course.
Content	- Introduction (1 hour): motivations, types of models, general structure of an electrical drive system, factors of development of electrical drive systems - DC machine model (2h): structure of the machine; excitation mode, dynamic equations in the time domain and in the Laplace domain; model simplifications (mechanical, electrical and electromechanical time constants); model improvements (armature resistance, saturation) - Space phasors and variable transformations (2 hour): Concordia Clarke and Park transformations

	- Synchronous machine model (4h): equations of the machine in 'abc', 'aß' and 'dq' coordinate systems; round rotor and salient pole machines; particularization to permanent magnet machines - Asynchronous machine model (4h): equations of the machine in 'abc', 'aß' and 'dq' coordinate systems - DC machine control (2h): general principle, main types of power supply, control with emf compensation, control with and without current measurement for low power machines - Synchronous machine control (4h): general principle of vector control in the 'dq' coordinate system; control with emf compensation, taking into account the inverter and the digital controller; flux weakening; particularization to surface mounted and interior permanent magnet machines, salient pole and wound inductor machines; brushless DC machines - Asynchronous machine control (4h): equations in the rotor flux coordinate system; general principle of vector control in this coordinate system; vector control with emf compensation; scalar V/f control
Inline resources	Moodle http://moodleucl.uclouvain.be/course/view.php?id=8002
Bibliography	- Transparents, livres de référence accessibles en ligne via l'intranet de l'UCL : • Wach, P., Dynamics and control of electrical drives, Springer, 2011, 456 p. • Veltman, A., Pulle, D. W., De Doncker, R. W., Fundamentals of electrical drives, Springer, 2007, 346 p. • De Doncker, R. W., Pulle, D. W., Veltman, A., Advanced electrical drives: Analysis, Modeling, Control, Springer, 2011, 462 p.
Other infos	Concerning the homework: - Supervised sessions are organized weekly in a computer classroom - The software used is Matlab/Simulink
Faculty or entity in charge	ELEC

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Electrical Engineering	ELEC2M	5		
Master [120] in Electro-mechanical Engineering	ELME2M	5		