UCLouvain

linma2671

2024

Advanced control and applications

5.00 credits	30.0 h + 30.0 h	Q1

Teacher(s)	Hendrickx Julien ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Basic training in control (level of INMA 1510) and in mathematics (level of a first-year master student in engineering).
Main themes	Model-based control (pole placement control, predictive control, LQ control, robust control) ; Implementation aspects of digital control.
Learning outcomes	**At the end of this learning unit, the student is able to :** Contribution of the course to the program objectives : • AA1.1, AA1.2, AA1.3 • AA2.1, AA2.2, AA2.3, AA2.4 • AA3.1, AA3.2 • AA5.3, AA5.4, AA5.5, AA5.6 • AA6.4 1 The aim of this course is to present different methods of model-based control (pole placement control, predictive control, LQ control, robust control) and to study the implementation aspects of digital control. These methods will be supported by real life cases studies. The course also involves control design exercises (MATLAB), and a set of laboratory sequences during which the students will implement some of these methods on pilot processes at the laboratory. At the end of this course, the students will be able to : • Understand the major issues of digital control design. • Calculate, with specialized software, digital controllers with specified performances. • Implement numerical control laws on real processes (in the laboratory). • Present major aspects of a theory or an application in automatic control.
Evaluation methods	The grade will be calculated as follows*: a) 40%: The seminar(s) presented: This evaluation assesses how well they have been able to communicate the ideas presented to the audience, the critical thinking and synthesis demonstrated in the preparation of the seminar, and their mastery of the subject they are presenting. b) 15%: Assignments and reports after external activities or seminars. c) 45%: Laboratories (work and reports). This grade is therefore entirely based on the work done during the semester. There is no exam, nor a second session. * *Specific provisions:* • If the (weighted) average grade for the combination of activities (a) and (b) is less than 10/20, a modified weighting system will be applied: (a) 70%, (b) 25%, and (c) 5%. • Each of the parts (a), (b), and (c) results in a single overall grade based on all the work and activities that comprise it. Failure to follow the methodological instructions defined on Moodle, especially regarding the use of online resources or collaboration among students, for any activity, will result in a overall grade of 0 for the assessment of that part of the course.

Teaching methods	1. Lectures and exercices: 3-5 lectures and problem-based learning sessions on (i) preliminary notions necessary for the class, (ii) sampling linear systems, and (iii) dealing with constraints on input and output signals. 2. Seminars : Between 6 and 12 seminars prepared by students. Each student/group of student receives several documents on a topic novel for them. Based on these documents and on their own research, they understand the new topic, critically analyze it, prepare a synthesis of its essential aspects, and present this synthesis to the other students. Each group can interact with the professor before their seminar, and a constructive feedback is provided after the seminar. The precise size of the group depends on the number of registred students. 3. Homeworks : One or two homeworks about sampling problems, done alone or by groups of two students. 4. Labs : Two or Three experiments in the laboratory (by groups of 2 or 3). The goal of each lab is to design a controler for a real and nontrivial dynamical system. They also allow students to face realistic (possibly unforeseen) practical problems. Depending on the sanitary conditions and practical constraints, the lab may be raplaced by virtual labs to be performed on computer 5. External activities : these will change every year. They may include : • presentation of an advanced control method by a researcher • seminar about practical control issues by someone from working on control problems in the industry • relevant visit of a plant/other facility where control methods are used • each student writes a short report after each external activity. Activities 1 and 2 (lectures, seminar, exercices) normally take place in classrooms, but may be moved partially or fully online depending on the sanitary situation, practical constraints, and the number of registered students.
Content	• Discretization of continuous models, Shannon's theorem, choice of sampling periods • Classical digital control (numerical PID) • Predictive control • Prediction compensation of measurable perturbations • Multivariable control, decoupling, linear quadratic control • Observers, Kalman filter • Delay compensation • Parameterization of Youla Kucera • Recursive model estimation • Robust control • Iterative controller design • Controller design with different methods using MATLAB and SIMULINK • Test of different control methods on pilot processes. The course comprises a set of lectures on theoretical aspects in control design or regarding industrial control applications developed by members of the Automatic Control Lab, as well as a set of compulsory exercises and laboratory sequences. Moreover, each student will have to make an oral presentation on a theoretical topic, or on results obtained in the laboratory or, finally, on an article describing an industrial application.
Inline resources	http://moodleucl.uclouvain.be/course/view.php?id=7955
Other infos	Knowledge of basic control techniques (e.g. LINMA 1510) and dynamical systems is expected.
Faculty or entity in charge	MAP

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Biomedical Engineering	GBIO2M	5		🔍
Master [120] in Electro-mechanical Engineering	ELME2M	5		🔍
Master [120] in Mathematical Engineering	MAP2M	5		🔍
Master [120] in Energy Engineering	NRGY2M	5		🔍