UCLouvain

linma2361

2024

Nonlinear dynamical systems

5.00 credits	30.0 h + 22.5 h	Q1

Teacher(s)	Absil Pierre-Antoine ;Massart Estelle ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Background in calculus and linear algebra (level of LEPL1101 and LEPL1102)
Main themes	The course is an introduction to the analysis and synthesis of nonlinear dynamical systems. The mathematical tools are illustrated on different applications, preferentially in the fields of neurodynamics, nonlinear control, and physics. Further specific illustrations are presented by the students at the end of the course.
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 • AA5.5, AA5.6 At the end of the course, the student will be able to: 1 • Make adequate use of basic mathematical tools to model, analyze, and design nonlinear dynamical systems, in areas such as neurodynamics, nonlinear control, and physics. Transversal learning outcomes : • Use a reference book in English; • Discuss and criticize research articles ; • Report in writing and present the results orally.
Evaluation methods	• Work carried out during the term: homework assignments, exercises, or laboratory work. These activities are thus organized (and evaluated) only once per academic year. • Exam: written report and oral presentation of a project, including a bibliographical part (article or book chapter reading) and computer illustrations of the theory. The final grade is 1/2 D + 1/2 E, where D is the grade of the work carried out during the term and E is the grade of the exam. Any violation of the instructions provided on Moodle, for any homework assignment, may lead to a global grade D = 0. The use of generative AI software such as chatGPT is authorized for assistance in writing the reports/assignments requested as part of 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, ...). In addition, external information sources must be systematically cited in compliance with bibliographic referencing standards. Further information is provided in the "Course outline" document available on Moodle (see "Online resources" below).
Teaching methods	• Lectures. • Homeworks, exercices, or laboratory work to be carried out individually or in small groups.
Content	• Introduction to nonlinear phenomena • Multiple equilibrium points and systems in the plane • Lyapunov functions, gradient systems, stability • Limit cycles • Hopf bifurcations, asymptotic methods • Introduction to chaos Depending on the choice of the course book, some of the following themes may also be touched : • Introduction to dynamical models in neuroscience • Simple neural computation models, Hopfield networks • Stabilization of equilibrium points • Coupled oscillators, synchronization phenomena, and collective motions • Input-output tools for nonlinear system analysis

Inline resources	https://moodle.uclouvain.be/course/view.php?id=1445
Bibliography	• Textbook • Complementary notes posted on Moodle Further information is provided in the "Course outline" document available on Moodle.
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 Physics	PHYS2M	5		
Master [120] in Energy Engineering	NRGY2M	5		