UCLouvain

lmat2215

2022

Homological algebra

5.00 credits	30.0 h + 15.0 h	Q1

This biannual learning is being organized in 2022-2023

Teacher(s)	Van der Linden Tim ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	It is recommended that the student be familiar with abstract mathematical structures such as vector spaces as covered in LMAT1131 or LINFO1112 or LEPL1101, Euclidean or affine spaces as covered in LMAT1131 or LMAT1141, groups as covered in LMAT1231 or LPHYS2211, or topological spaces as covered in LMAT1323.
Main themes	Complexes of modules, their homology ; Simplicial objects and the example of the singular homology of a topological space; The Dold-Kan theorem which gives the equivalence between complexes and simplicial objects of modules; Abelian categories: first properties and homological lemmas.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 **Contribution of the course to the learning outcomes of the master's program in mathematics.** **By the end of this activity, the student will have progressed in his/her ability to :** (a) Know and understand a fundamental foundation of mathematics. In particular, he/she will have developed the ability to : i. Recognize the fundamental concepts of important current mathematical theories. ii. Establish the major connections between these theories. (b) Demonstrate abstraction, reasoning and critical thinking skills. In particular, the student will have developed the ability to : i. Identify unifying aspects of different situations and experiences. ii. Reason within the framework of the axiomatic method. iii. Construct and write a demonstration in an independent, clear and rigorous manner. (c) analyze a mathematical problem and propose adequate tools to study it independently. The contribution of this course to the development and mastery of the competences and skills of the program(s) can be found at the end of this document, in the section "Programs/training courses offering this course". **Methods of evaluation of students' achievements :** The evaluation is based on a written exam. The knowledge and understanding of the notions, examples and fundamental results, the ability to construct a coherent reasoning, the mastery of the demonstration techniques introduced during the course are tested.
Evaluation methods	Part of the final mark will take into account continuous evaluation throughout the course. This part of the mark will serve for each exam session and cannot be represented. There will also be an oral exam (exercises, 40% and theory, 60%). At the exam, we test knowledge and understanding of the notions and fundamental results of the course, as well as mastery of the basic techniques of homological algebra.
Teaching methods	The learning activities consist of lectures and practical work sessions. Lectures aim to introduce fundamental concepts, motivate them by showing examples and establishing results. The results are often presented with historical comments and applications. The practical work sessions aim to assimilate the theory through calculation exercises and reflection exercises.
Content	The aim of this activity is to expose the fundamental concepts of homological algebra. The following subjects will be treated within the framework of this course : 1. Categories of modules 2. Projective and injective modules 3. Chain complexes 4. Homology of a complex 5. Singular homology of a topological space 6. Morphisms of complexes and homotopies between them 7. Simplicial objects and the Dold-Kan theorem 8. Abelian categories: examples and basic properties

	9. Homological lemmas in abelian categories
Inline resources	Course webpage on Moodle, where also the latest version of the course notes is available
Bibliography	S. Mac Lane, Homology, Springer, 1967. Ch. A. Weibel, An introduction to homological algebra, Cambridge University Press, 1994.
Faculty or entity in charge	MATH

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Mathematics	MATH2M	5		🔍
Master [60] in Mathematics	MATH2M1	5		🔍