UCLouvain

lmat1321

2026

Functional analysis and partial differential equations

7.00 credits	45.0 h + 45.0 h	Q1

Teacher(s)	Van Schaftingen Jean ;
Language :	French > English-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Cours LMAT1121, LMAT1122, LMAT1131, LMAT 1221 (or equivalents).
Main themes	Banach, Hilbert, Lebesgue, and Sobolev spaces, dual spaces, elliptic problems.
Learning outcomes	**At the end of this learning unit, the student is able to :** **Contribution of the course to learning outcomes in the Bachelor in Mathematics programme.** **By the end of this activity, students will have made progress in :** By the end of the programme, the graduate is able to : 1) recognise and understand a basic foundation of mathematics. Choose and use the basic tools of calculation to solve mathematical problems. Recognise the fundamental concepts of important current mathematical theories. Establish the main connections between these theories, analyse them and explain them through the use of examples. 2) identify, by use of the abstract and experimental approach specific to the exact sciences, the unifying features of different situations and experiments in mathematics or in closely related fields (probability and statistics, physics, computing). 3) show evidence of abstract thinking and of a critical spirit. Argue within the context of the axiomatic method Recognise the key arguments and the structure of a proof. Construct and draw up a proof independently. Evaluate the rigour of a mathematical or logical argument and identify any possible flaws in it. Distinguish between the intuition and the validity of a result and the different levels of rigorous understanding of this same result. 4) be clear, precise and rigorous in communicating. Write a mathematical text in French according to the conventions of the discipline. Structure an oral presentation in French, highlight key elements, identify techniques and concepts and adapt the presentation to the listeners' level of understanding. Communicate in English (level C1 for reading comprehension, level B2 for listening comprehension and for oral and written expression, CEFR). 5) learn in an independent manner. Find relevant sources in the mathematical literature. Read and understand an advanced mathematical text and locate it correctly in relation to knowledge acquired. **Learning outcomes specific to the course.** **By the end of this activity, students will be able to :** - Use functional spaces to solve analytical problems, - Use the basic principles of functional analysis. - Identify the natural norm or inner product to solve analytical problems. - Define the natural notion of weak solutions. - Identify dual spaces.
Evaluation methods	The assessment will be decomposed in several parts : • 20% for exercises done at home or in the classroom during the term, • 80% for the written exam covering the whole course. The grades for exercises done in the classroom during the term will be carried over to each session of the entire academic year, without the possibility of presenting them again.

Teaching methods	• Lectures and discussions aiming to introduce fundamental concepts, to explain them by showing examples and by determining their results, to show their reciprocal connections and their connections with other courses in the programme for the Bachelor in Mathematics. • Exercise sessions aiming to teach how to select and use calculation methods and how to construct proofs.
Content	• Abstract and concrete metric and normed spaces (including Lebesgue spaces), topology, convergence and continuity. • Completeness, density, contractive mappings, meagre sets and uniform boundedness principle. • Hilbet bases, approximations in Lebesgue spaces, compactness and spectral theory. • Dual spaces and their representation, Hahn–Banach theorem, bidual and reflexivity, weak convergences and topologies.
Inline resources	Online ressources on Moodle, including lecture notes and problem sheets and solutions for the exercise sessions.
Faculty or entity in charge	MATH

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Minor in Mathematics	MINMATH	7		🔍
Bachelor in Mathematics	MATH1BA	7		🔍