UCLouvain

lmat2130

2021

Partial differential equations

5.00 credits	30.0 h + 15.0 h	Q1

Teacher(s)	Olbermann Heiner ;
Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	- LMAT1221 Analyse mathématique 3 (or an advanced analysis course covering sequences and series of functions and the divergence theorem), - LMAT1321 Analyse fonctionnelle et équations aux dérivées partielles (or an introductory course on Functional Analysis), - LMAT1322 Théorie de la mesure (or an introductory course on measure theory and the Lebesgue integral).
Main themes	The course develops techniques to solve problems involving partial differential equations based on real analysis tools.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 **Contribution of the course to learning outcomes in the Master in Mathematics programme.** **By the end of this activity, students will have made progress in :** - Choose and use calculation tools to solve mathematical problems. - Identify 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. - 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. - Show evidence of abstract thinking and of a critical spirit. - Argue within the context of the axiomatic method. - Construct and draw up a proof independently, clearly and rigorously. - Recognise the key arguments and the structure of a proof. - 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. - Write a mathematical text according to the conventions of the discipline. - Find sources in the mathematical literature and assess their relevance. - Correctly locate an advanced mathematical text in relation to knowledge acquired. - Ask relevant and lucid questions on an advanced mathematical topic in an independent manner. **Learning outcomes specific to the course.** **By the end of this activity, students will be able to :** - State, prove and illustrate propositions concerning properties of solutions of partial differential equations, and also the existence and uniqueness of such solutions. - Propose one or several strategies to establish the existence of solutions. - Apply tools from real analysis to solve a problem. - Manipulate notions from advanced analysis. - Contextualize mathematical tools in their historical setting and understand how they evolved.
Evaluation methods	Learning will be assessed by means of homework during the semester and by a final examination. **Questions in the final examination will ask students to :** - reproduce material, especially definitions, theorems, proofs and examples - demonstrate a certain mastery of the available tools - explain the limits of a method or a tool **Assessment will be on the basis of :** - knowledge, understanding and application of the different mathematical objects and methods from the course - precision of calculations - rigour of arguments, proofs and reasons - quality of presentation of answers

Teaching methods	Learning activities consist of lectures and practical exercises. The lectures focus on and explain the subject's topics, tools, techniques and methods. The supervised practical exercises allow students to become familiar with topics, tools, techniques and methods in the field. The practical exercise sessions aim to teach students how to choose and use methods in order to solve problems. Activities are held in presential sessions.
Content	• Harmonic functions: Mean value property, regularity, maximum principle • Harnack inequality, Liouville Theorem • Gauss-Green formulas, fundamental solution, distributions, Green's function • Perron's method • Sobolev spaces, elliptic boundary value problems • Heat equation: Fundamental solution, maximum principle, regularity • Wave equation: Explicit solution
Inline resources	Lecture notes will be available via Moodle.
Bibliography	• Lawrence C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, AMS, 2010. • Augusto C. Ponce, Elliptic PDEs, Measures and Capacities, EMS Tracts in Mathematics, vol. 23, European Mathematical Society (EMS), Zürich, 2016.
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 [120] in Physics	PHYS2M	5		
Master [60] in Mathematics	MATH2M1	5		
Master [60] in Physics	PHYS2M1	5		
Master [120] in Mathematical Engineering	MAP2M	5		