



This biannual learning unit is not being organized in 2026-2027 !

Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	Depending on the subject, mathematics skills at the level of the end of the Bachelor in Mathematics or first year Master in Mathematics.
Main themes	The topic considered varies from year to year depending on the research interests of the course instructor.
Learning outcomes	<p>At the end of this learning unit, the student is able to :</p> <p>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:</p> <ul style="list-style-type: none"> • Show evidence of independent learning. • Analyse a mathematical problem and suggest appropriate tools for studying it in depth. • Begin a research project thanks to a deeper knowledge of one or more fields and their problematic issues in current mathematics. He will have made progress in: <ol style="list-style-type: none"> 1 • Develop in an independent way his mathematical intuition by anticipating the expected results (formulating conjectures) and by verifying their consistency with already existing results. • Ask relevant and lucid questions on an advanced mathematical topic in an independent manner. <p>Learning outcomes specific to the course. The course aims to initiate research in the field under consideration. Specific learning outcomes vary depending on the field.</p>
Evaluation methods	A written exam, which tests the knowledge and understanding of fundamental concepts, examples and results of the course, as well as the ability to construct a coherent argument, and the mastery of the techniques of proofs introduced during the course. An optional homework assignment will supplement the written exam. It will count for 30% of the final grade provided the written-exam grade is at least 8/20 and the homework grade is higher than the written exam grade.
Teaching methods	The course is taught through lectures. During sessions, students are asked to give their contribution in the form of questions or of presentations of parts of the course as previously established by the teacher. It is recommended that the student be familiar with the fundamental notions of group theory, as developed, for example, in the course LMAT1231.
Content	<p>This activity consists in introducing one or more advanced subjects in mathematics.</p> <p>The topic considered varies from year to year depending on the research interests of the course instructor. Geometric group theory was developed in the 80s and seeks to study finitely generated groups via their actions by isometries on metric spaces. For example, given such a group and a generating set, one can consider its Cayley graph, a graph on which the group acts freely and transitively. Geometric features of this graph (or of any space on which the group acts with nice properties) are often deeply linked to algebraic properties of the group itself. A key example is Gromov hyperbolicity, characterised by the slimness of geodesic triangles. This course will focus on groups that act suitably on hyperbolic spaces, known as hyperbolic groups.</p> <ul style="list-style-type: none"> • Geometric group actions: finitely generated groups, Cayley graphs, geometric group actions, quasi-isometries, Milnor–Švarc lemma. • Hyperbolic geometry, Gromov-hyperbolicity: Poincaré disc & half-plane models; slim/thin triangles, delta-hyperbolicity of metric spaces. • Hyperbolic groups, definitions & first properties: Morse lemma, invariance of delta-hyperbolicity under quasi-isometries; hyperbolic groups: characterisation via geometric actions. • Algebraic and algorithmic consequences: finite presentability, finite subgroups, free subgroups, finiteness properties, and more. • Different characterisations of hyperbolicity (if time allows): via Dehn & divergence functions.

Faculty or entity in charge	MATH
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Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Mathematics	MATH2M	5		