

**COURSE OF STUDY**

**TWO-YEAR MASTER OF SCIENCE  
PROGRAMME  
IN MATHEMATICS**

**ACADEMIC YEAR**

**2024-2025**

**ACADEMIC SUBJECT**

**SEMIGROUPS THEORY AND APPLICATIONS**

General information	
Term	First semester (September 23, 2024 – December 20, 2024)
European Credit Transfer and Accumulation System credits (ECTS)	4
SSD	MAT/05 – Mathematical Analysis
Language	Italian
Mode of attendance	Not mandatory

Lecturer	
Name and surname	Mirella Cappelletti Montano
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Department and office	Department of Mathematics, room 12 third floor
Virtual meeting room	Mteams code: cdmdlly
Web page	<a href="https://www.dm.uniba.it/it/members/cappellettimontano">https://www.dm.uniba.it/it/members/cappellettimontano</a>
Office hours	Every Tuesday, from 3 p.m to 5 pm., or by appointment.

Work schedule			
	Total	Lectures	Hands-on learning
Hours	100	32	
ECTS credits	4	4	

Learning objectives	
	Acquiring the main tools of semigroup theory, with applications to suitable classes of differential problems.

Course prerequisites	
	The prerequisites for the course involve Mathematical knowledge which usually is acquired during a degree of L-35 class. Especially: classical analysis of one and several variables, general topology, linear algebra, the theory of Banach spaces and of bounded linear operators.

Syllabus	
Course contents	<b>C<sub>0</sub> semigroups:</b> Uniformly continuous semigroups. C <sub>0</sub> semigroups: examples and related properties. Generator of a C <sub>0</sub> -semigroup: examples and related properties. Resolvent of the generator of a C <sub>0</sub> -semigroup and related properties. Abstract Cauchy Problem.

	<p><b>Generation theorems:</b> Hille-Yosida Theorem. Dissipative and m-dissipative operators. Lumer-Phillips Theorem.</p> <p><b>Applications:</b> Analytical semigroups. Positive semigroups. Markov semigroups. Applications to parabolic differential problems. Degenerate second-order differential operators in continuous functions spaces: Feller analysis.</p> <p>Generation/approximation theorems for positive semigroups: Trotter theorem and Schnabl theorem. Positive approximation processes: application of Approximation Theory to Semigroup Theory.</p>
Reference books	<p>[1] K.J. ENGEL - R. NAGEL, One-parameter Semigroups for Linear Evolution Equations, Graduate Texts in Mathematics 194, Springer, 2000.</p> <p>[2] A. Pazy, Semigroups of operators and applications to partial differential operators, Applied Mathematical Sciences, Springer, 1974</p>
Additional course materials	
Repository	Support and in-depth material will be available on the e-learning platform of the Department of Mathematics.

Expected learning outcomes	
Knowledge and understanding	Acquiring the main concepts and techniques in $C_0$ -semigroups theory.
Applying knowledge and understanding	Being able to apply the theoretic results to the study of differential problems and to analyze the underlying models.
Soft skills	<i>Making judgements:</i> Being able to choose the appropriate mathematical tools to understand proofs and to solve mathematical problems.
	<i>Communication skills:</i> Acquiring the necessary Mathematical language and formalism to comprehend textbooks and present the results.
	<i>Learning skills:</i> Acquiring suitable learning methods that will help the students to select the source of information and to reprocess the notes.

Teaching methods	
	In person frontal lessons

Assessment	
Assessment methods	Oral exam starting from the presentation of a chosen topic.
Evaluation criteria	<ul style="list-style-type: none"> <li><i>Knowledge and understanding:</i> mastering and deep understanding of the main theoretical contents</li> <li><i>Applying knowledge and understanding:</i> being able to use the theoretical results in the applications.</li> </ul>



	<ul style="list-style-type: none"><li>• <i>Making judgement</i>: approaching notions in a critical way and using them in solving problems.</li><li>• <i>Communication skills</i>: mastering the mathematical language and formalism in semigroup theory.</li><li>• <i>Learning skills</i>: organizing knowledge and being able to autonomously choose the source of information.</li></ul>
Grading policy	The final grade, out of thirty, is assigned on the basis of an oral exam. The exam is passed if the final grade is greater than or equal to 18/30. The grade depends on the achievement of the expected learning outcomes.

Further information	
	Attendance is strongly recommended.