





5.00 credits

30.0 h + 22.5 h

Q1

Teacher(s)	Jungers Raphaël ;Remacle Jean-François ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Basic formation in Linear Algebra and numerical computing (LEPL1101, LINMA1170).
Main themes	<p>This course builds on the solid mathematical foundations of matrix theory and graph theory to develop algorithmic solutions to engineering problems.</p> <ul style="list-style-type: none"> # Polynomial and structured matrices: Euclidean algorithm, Smith and Hermite normal forms, fast algorithms # Matrix semigroups: algebraic structure, algorithms, and applications (e.g., nonnegative factorization, joint spectral characteristics) # Sparse matrices and chordal structures # Preconditioning of iterative methods, preconditioned conjugate gradients # Advanced topics to be presented in a seminar (combinatorial optimization and algebraic techniques, spectral and algebraic graph theory, tropical algebra, tensors and multilinear algebra, symbolic computation, matroid theory)
Learning outcomes	<p>At the end of this learning unit, the student is able to :</p> <p>The course enhances the following learning outcomes:</p> <ul style="list-style-type: none"> # AA1.1, AA1.2 # AA5.5 # AA6.3 <p>More precisely, the student will be able to :</p> <ul style="list-style-type: none"> # Master advanced linear algebra # Analyze the mathematical properties of various problems in applied mathematics and design algorithmic solutions using advanced mathematical theories. # Apply or develop specific algorithms for applications in statistics, signal processing, imaging, and dynamic systems. # Implement methods in high-level software and validate their behavior on practical problems. <p>Transversal skills:</p> <ul style="list-style-type: none"> # Collaborate in small teams to numerically solve mathematical problems

Evaluation methods	<p>The evaluation of the students is partly based on a written (or oral, depending of the circumstances) exam organized according to the rules imposed by the EPL. The exam material corresponds to the contents of the lectures and lecture notes, with the possible exception of certain parts specified after the last session of the course.</p> <p>For a written exam, in case of doubt, the teacher might invite the student for a supplementary oral exam.</p> <p>The other part of the evaluation is based on the assignments and presentations made during the semester, and will be taken into account both in january and september</p>
Teaching methods	<ul style="list-style-type: none"> • Courses Ex-cathedra • Homeworks by group of students • Flipped classrooms presentations by the students
Content	<ol style="list-style-type: none"> 1. Canonical forms and computing on the quotient of a set 2. Jordan's theorem: proof and consequences 3. Polynomial matrices: Smith and Hermite normal forms, fast algorithms 4. Structured matrices 5. Joint spectral characteristics 6. Direct methods for solving systems: LU, Cholesky, pivoting, reordering (RCMK), sparse storage, fill-in. 7. Krylov iterative methods: Arnoldi iteration, conjugate gradients, GMRES, Lanczos. 8. Sparse matrices and chordal structures 9. Preconditioning of iterative methods, preconditioned conjugate gradients
Inline resources	http://moodleucl.uclouvain.be/course/view.php?id=7969
Bibliography	<p>Ouvrages de référence :</p> <p># G.H. Golub and C.F. Van Loan (1989). Matrix Computations, 2nd Ed, Johns Hopkins University Press, Baltimore.</p> <p># P. Lancaster and M. Tismenetsky (1985). The Theory of Matrices, 2nd Ed, Academic Press, New York</p> <p># Trefethen, L. N., & Bau III, D. Numerical linear algebra (Vol. 50). Siam.</p>
Faculty or entity in charge	MAP

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Mathematics	MATH2M	5		
Master [120] in Electrical Engineering	ELEC2M	5		
Master [120] in Mathematical Engineering	MAP2M	5		
Master [120] in Data Science Engineering	DATE2M	5		
Master [120] in Data Science: Information Technology	DATI2M	5		