







5 credits	30.0 h + 22.5 h	Q1
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Teacher(s)	Jungers Raphaël ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	<p>The course builds on the solid mathematical foundations of Matrix theory in order to elaborate algorithmic solutions to major challenges involving computations with/on matrices.</p> <ul style="list-style-type: none"> • Matrices defined over a field/ring/nonnegative: applications and challenges • Canonical forms, decompositions, eigen- and singular values • Norms, convexity, structured matrices: sparse/adjacency matrices • Recent computational challenges: Nonnegative Matrix Factorization, matrix semigroups
Aims	<p>Contribution of the course to the program objectives :</p> <ul style="list-style-type: none"> • AA1.1, AA1.2 • AA5.5 • AA6.3 <p>After successful completion of this course, the student will :</p> <p>1</p> <ul style="list-style-type: none"> • have acquired a solid basis of matrix theory and its applications in several engineering disciplines • understand the use of matrix properties in the solution of these problems • have acquired a solid background in matrix problems involving eigenvalues, singular values, non-negative and polynomial matrices • have shown how to apply his theoretical background in concrete matrix problems. • be able to model an engineering problem by choosing the adequate concepts and the good tool within the wide panel offered by Matrix theory. <p>-----</p> <p><i>The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".</i></p>
Evaluation methods	<p>The evaluation of the students is partly based on an exam organized according to the rules imposed by the EPL. The exam material corresponds to the contents of the course material, with the possible exception of certain parts specified in a document available on Moodle after the last session of the course.</p> <p>The other part of the evaluation is based on the homeworks made during the semester.</p> <p>More elaborate information on the on the evaluation procedure is given in the course plan, made available on Moodle at the beginning of the academic year.</p>
Teaching methods	<ul style="list-style-type: none"> • Regular classes with a schedule fixed by the EPL. • Exercises or homeworks made individually or in small groups, with the possibility to consult teaching assistants. Solutions to the problems are made available afterwards.
Content	<p>After an introduction recalling some basic notions, we discuss the following topics:</p> <ol style="list-style-type: none"> 1. Complements on determinants 2. The singular value decomposition and its applications. Angles between subspaces, generalized inverses, projectors, least-squares problems 3. Eigenvalue decomposition: Schur and Jordan form 4. Approximations and variational characterization of eigenvalues 5. Congruence and stability: inertia, Lyapunov equation, stability analysis of dynamical systems 6. Structured and Polynomial matrices: Euclid algorithm, Smith normal form, fast algorithms. 7. Nonnegative matrices: Perron-Frobenius theorem, stochastic matrices 8. Matrix semigroups: algebraic structure, algorithms and applications (NMF, Joint Spectral Characteristics)
Inline resources	<p>http://moodleucl.uclouvain.be/course/view.php?id=7969</p>
Bibliography	<p>Le support de cours se compose d'ouvrages de référence, de notes de cours détaillées et de documents complémentaires disponibles sur Moodle.</p> <p>Ouvrages de référence :</p> <ul style="list-style-type: none"> • G.H. Golub and C.F. Van Loan (1989). Matrix Computations, 2nd Ed, Johns Hopkins University Press, Baltimore. • P. Lancaster and M. Tismenetsky (1985). The Theory of Matrices, 2nd Ed, Academic Press, New York

Faculty or entity in charge	MAP
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Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Data Science Engineering	DATE2M	5		
Master [120] in Electrical Engineering	ELEC2M	5		
Master [120] in Statistics: General	STAT2M	5		
Master [120] in Mathematical Engineering	MAP2M	5		
Master [120] in Mathematics	MATH2M	5		
Master [120] in Physics	PHYS2M	5		
Master [120] in data Science: Information technology	DATI2M	5		