Master Mathématiques et Applications
Parcours Scientific Computing : Master 2

2026-2027

https ://sciences-technologies.univ-lille.fr/mathematiques/formation/master-mention-mathematiques-et-applications/parcours-cs

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Scientific and professional objectives

Scientific Computing Master 2 is a specialization within the Master " Mathématiques et Applications de l'Université de Lille".

This formation aims to :

- provide solid bases in modelling, applied mathematics and scientific computing
- provide a solid background in Scientific Computing to handle scientific problems in modelling or applied mathematics
- introduce students to research in academic or industry

Students trained in this "parcours" meet the growing need for scientific computing in industrial groups of various sizes and in academic research laboratories.

Admission

Students in M1 Scientific Computing of University of Lille advance in M2.

Admission in M2 Scientific Computing requires to candidate from CAMPUS FRANCE (for interntional students) or to e-candidat (for students that succeed their M1 in the EU).

Admission is subject to review of the application and is contingent upon the program's capacity.

Graduates of engineering schools or holders of the external competitive examination for teaching positions (agrégation) may also apply. Foreign degrees are subject to validation by the relevant committee of the University.

Bourses d'excellence

Excellence scholarships may be awarded based on academic merit.

These scholarships are offered by the Information and Knowledge Society Graduate Program or by the CDP "C^2EMPI".

Applications for these scholarships are separate from the application to the master's program.

Organisation

Fall semester

BCC 1 « Résoudre des problèmes complexes en mobilisant les concepts fondamentaux et numériques des mathématiques »

— UE Math. Tools for scientific computing. Finite Element Methods-6 ECTS
— UE Math. Tools for scientific computing. Finite Volume Methods-6 ECTS

BCC 2 « Mettre en oeuvre les usages avancés et spécialisés des outils numériques »

— UE Refresher in computer sciences-4,5 ECTS
— UE Super computing-10,5 ECTS

BCC 3 « Construire son projet professionnel »

— UE English- 3 ECTS

Spring semester

BCC 5 « Mettre en oeuvre les usages avancés et spécialisés des outils numériques »

— UE Applied scientific computing 1 - 9 ECTS
— UE Applied scientific computing 2- 9 ECTS

BCC 4 « Contribuer à la transformation des connaissances dans un contexte professionel ou académique»

— Internship - 12 ECTS

Calendrier (prévisionnel) 2026/27

Réunion de rentrée : 27 aout 2026 10h 116 Bat M3

Premier semestre
Début des cours : early september 2026
Interruption pédagogique : semaine du 26 octobre
Examens : to be specified

Vacances de Noël : end of december

Second semestre
Début des cours : early january
Vacances d'hiver : semaine du premier mars
Vacances de printemps : du 17 au 30 avril
Examens :
Soutenances des mémoires et stages : early september 2027

Épreuves de seconde session

Programme des enseignements

Fall semester

Math. Tools for scientific computing. Finite Element Methods CM 16h + TD 24h

Syllabus Variational formulation of elliptic PDEs : strong/weak solutions ; derivation of a variational formulation ; well-posedness (coercive case ; Lax-Milgram) ; equivalence with the strong form ; treatment of different types of data (variable coefficients, homogeneous/non-homogeneous cases) and boundary conditions (pure Dirichlet, pure Neumann, mixed-type, Robin-type) Variational approximation of elliptic problems : internal approximation ; matricial viewpoint ; Céa's lemma ; general convergence theorem Finite elements : definition of a FE (unisolvence, shape functions) ; reduction/reconstruction/interpolation operators ; stiffness/mass matrices Lagrange FE in 1D : algebraic realization (quadrature formulas, static condensation) ; convergence theorems (interpolation, duality techniques) Lagrange FE in 2D/3D : barycentric coordinates ; algebraic realization (assembly procedure, cubature formulas) ; convergence theorems (interpolation, mesh regularity) Approximation of parabolic problems : diagonalization of the heat operator ; Euler/FE time/space schemes (explicit and implicit versions) ; convergence theorems ; CFL condition ; mass lumping ; implementation Implementation of 1D Lagrange FE in Matlab/Octave Project in C/C++ (2D, use of Gmsh)

Modalités d'évaluation a PR project grade will be calculated as the weighted average of (2 report grades + oral presentation grade) divided by 3, with the oral presentation taking place before a jury. The final grade will be calculated as (EXAM + 2PR) divided by 3, where EXAM is the final exam grade. In the event of a resit, the resit grade will replace the EXAM grade.

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Math. Tools for scientific computing. Finite Volume Methods CM 16h + TD 24h

Syllabus Modelling of transport and propagation phenomena : derivation of scalar conservations laws and of wave equations. Modelling of diffusion, transport and propagation phenomena : derivation of scalar conservations laws Finite Volume methods for conservation laws : Lax-Friedrichs, Lax-Wendroff, Godunov and Roe schemes, implementation and numerical analysis. Finite volume methods for elliptic and parabolic problems : implementation and numerical analysis.

Modalités d'évaluation a PR project grade will be calculated as the weighted average of (2 report grades + oral presentation grade) divided by 3, with the oral presentation taking place before a jury. The final grade will be calculated as (EXAM + 2PR) divided by 3, where EXAM is the final exam grade. In the event of a resit, the resit grade replaces the EXAM grade.

Refresher in computer sciences. CM 12 + TD 18

Syllabus Description The main goal of this lecture is to provide to the students the knowledge and skills of the C language. As this language is the main langage used to implement operating systems, this will enable the student to see the link between algorithmic (programming) and the computer they're using (more precisely a single processor in the context of this lecture). As a consequence, the student will also get used to UNIX operating systems. Program Quick survey on the UNIX operating system and command line operations. Programming in C (basics, separated compilation – including using a makefile, structures, pointers and dynamic allocation). Short overview on how the filesystem / processor are dealt with on UNIX. Acquired skills Basic knowledge on UNIX operating system, makefile and programming in C, and Understanding how a processor is working.

Modalités d'évaluation : The project grade (PR) and the final exam grade (EXAM) will give the final grade = (PR + EXAM)/2. In the event of a resit, the resit grade replaces the EXAM grade.

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Super computing. CM 28 + TD 42

Syllabus Overview of parallel distributed machines (shared-memory machines, distributed-memory machines, coprocessors and GPU accelerators, large-scale environments – A case study : Grid'5000). Parallel distributed algorithm design and programming Paradigms of parallel and distributed programming (task parallelism, data parallelism, shared memory paradigm, message passing paradigm). Parallel distributed programming environments and tools (OpenMP, MPI, Cuda). Fundamental problems of parallel distributed programming (task / data partitioning, load balancing, scheduling, fault tolerance, performance evaluation). Getting started with parallel machine administration through Grid'5000 (resource reservation, application deployment, monitoring, fault tolerance, etc.). Towards the exascale era : challenges and alternatives of massively parallel and heterogeneous programming

Modalités d'évaluation The project grade (PR) and the final exam grade (EXAM) will give the final grade = (PR + EXAM)/2. In the event of a resit, the resit grade replaces the EXAM grade.

Fourth semester : options. CM 24 + TD 36
Two advanced courses to be chosen between

Machine learning and optimization for scientific computing The student will learn the concepts of parallel optimization assisted by statistical learning. He/She will be introduced to the methods of optimization, including meta-heuristics and Bayesian optimization, their coupling to machine learning and their parallelization. Engineering simulation will be considered as a field of application and experimentation.

Scientific computing for electrical engineering Study of continuous and discrete models describing electromagnetic phenomena. Propagation of uncertainties in numerical models Model order reduction and error estimator applied to electromagnetic phenomena. This course enables students to understand the numerical methods used in models describing the electromagnetic phenomena in low frequency. During the course, specific lectures required to understand and to program such methods are given. The student has to program his/her own numerical model during a project.