UCL Université catholique de Louvain

LFSAB1104

2012-2013

Numerical methods

5.0 credits	30.0 h + 30.0 h	1q

Teacher(s) :	Legat Vincent ;
Language :	Français
Place of the course	Louvain-la-Neuve
Main themes :	This course presents a broad overview of numerical methods, using calculus, algebra and computing science. The student must become aware of the relevant issues in selecting appropriate method and software and using them wisely, in terms of computational cost, numerical accuracy, complexity and stability. To make the presentation concrete and appealing, the programming environment MATLAB is adopted as a faithful companion. Topics include - Error analysis: modelling error, truncation error, convergence and approximation order, floating point number representation (IEEE754). - Approximation and interpolation: Lagrange polynomials, spline functions, NURBS, orthogonal polynomials, error estimators. - Numerical integration and differentiation: backward and centered finite difference, midpoint, trapezoidal and simpson formula, adaptive techniques. - Ordinary Differential Equations (ODE): Taylor and Runge Kutta methods, predictor-corrector methods, stability on unbounded intervals and perturbation analysis. - Linear equations: factorization methods and iterative techniques, complexity, computation of eigenvalues. - Nonlinear equations: bisection and Newton methods, optimisation applications. - Partial Differential Equations (PDE): boundary value problems (Laplace, heat equation, waves equation), approximation by finite differences. Although numerous concrete applications, the student will acquire a working knowledge in numerical methods using a problem-based learning environment;
Aims :	This course is intended as an introduction to techniques for carrying out numerical computation on computers, historically one of the fundamental disciplines of computer science. It may be considered to be a preparatory course for a course in numerical analysis. While mathematical in nature, emphasis is also given to programming techniques and style, and techniques for numerical methods. Laboratory exercises will be carried out using the MATLAB system; experience with this package is not assumed. The course serves three main purposes: (1) the understanding of basic numerical techniques with the underlying mathematical notions, (2) the maturity to interpret the reliability of numerical results, (3) the programming skills to implement simple numerical algorithms. At the end of the lecture, the student must be able to: - identify physical reality, mathematical model and numerical solution, - understand the numerical methods in terms of accuracy, convergence and stability, - select a numerical methods taking into account accuracy and cost requirements, - implement a numerical method in computer software, - interpret and to validate the computed results, which may lead to further refinement of the mathematical model The goal is to cover a wide range of numerical methods to obtain an approximate solution of problems of physics where an exact solution is not available. A broad knowledge is often decisive to choose the right method when developing a new code. A strong emphasis is put on the problem based learning where the participants analyze data, derive, implement, document and execute their own models. Finally, the analytical and the numerical approaches are presented as complementary tools. *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".*
Content :	This course presents a broad overview of numerical methods, using calculus, algebra and computing science. The student must become aware of the relevant issues in selecting appropriate method and software and using them wisely, in terms of computational cost, numerical accuracy, complexity and stability. To make the presentation concrete and appealing, the programming environment MATLAB is adopted as a faithful companion.
Other infos :	The evaluation has 2 components: an intermediary evaluation during the quadrimester and a final exam at the end of the quadrimester (written exam). The final mark is a combination of the scores in these two evaluations - Workfiles for each of the parts (available on the website and in

Cycle and year of study :	> Bachelor in Engineering > Bachelor in Information and Communication > Bachelor in Philosophy > Bachelor in Pharmacy > Bachelor in Engineering : Architecture > Bachelor in Computer Science > Bachelor in Psychology and Education: General > Bachelor in Economics and Management > Bachelor in Motor skills : General > Bachelor in Human and Social Sciences > Bachelor in Sociology and Anthropology > Bachelor in Political Sciences: General > Bachelor in Mathematics > Bachelor in Biomedicine > Bachelor in Religious Studies > Master [120] in Physics
Faculty or entity in charge:	BTCI