

Master of research in *High efficiency Algorithms and Modelisation*

The *High efficiency Algorithms and Modelisation* curriculum aims to deliver in-depth knowledge of methods and tools used in the advanced algorithmics field.

At the end of this research speciality, students are able to justify wide skills in parallel/distributed algorithms, geometric algorithms and optimisation methods. The curriculum is divided into three steps:

- gain fundamental knowledge of advanced algorithmics (numerical algo., complexity, geometrical algo. and specification)
- understand how these abstract fundamentals can be used in solving software
- master the English bibliographical search technics

UE01 fundamental algorithmics and modelisation

Attended on A2009, result 15/20

The following points are taught:

- fundamental algorithmics (complex data structures, randomized algo., complexity, ...)
- numerical algorithms (eigenvalue, eigenvector, eigenspace and limit of matrix, Markov chains, ...)
- optimization (multi-criteria optim., formal models, ...)

UE02 algorithmics and advanced architectures

Attended on A2009, result 13/20

The following point are taught:

- IA and soft computing technics (multi-agent architecture, neural networks, genetic algo., learning technics, ...)
- geometric algorithmic technics (polygonal lines, triangulation, 3D shape rebuilding, ...)
- new distributed architectures (computing grid, peer to peer networks, sensor network, ...)

UE03 projects

Attended on A2009, result 15.5/20

Students have to carry out three projects related to each main topic of the curriculum. One transverse project is done too.

Projects :

Vehicle traffic simulator (multi-agent approach)

Multi node autonomous energy balancing algorithm

Several distributed matrix multiplication methods

Distributed taboo search (transverse project)

UE04 English bibliographical search

Attended on A2009, result 15.5/20

The aim is to be able to abstract English research articles.

Articles :

BOINC: A System for Public-Resource Computing and Storage (David P. Anderson)

Linear expected sweep-algorithm for planar convex hulls (Bruno Adam, Pierre Kauffmann, Dominique Schmitt and Jean-Claude Spehner)

Analysis and Design of Holonic Manufacturing Systems (A. Giret, V. Botti)

UE05

Attended on A2009, result 14.5/20

Collaborative approach of problem solving

- swarm algorithms and reactive agents (models inspired from physics or biology, social models or holonic)
- meta-heuristic collaboration
- collaborative approach for environment perception (3D rebuild and movement analysis)

Geometrical shape modelisation and computation

- tessellation (tiling)
- convex hull, enclosing circle
- Delaunay/Voronoi diagram
- shape matching and 2D/3D indexation

Distributed numerical algorithms

- programming models (messages, synchronous/asynchronous communications or iterations)
- load balancing for distributed algorithms
- cluster computation tools (MPI, Jace, ...)

Master of engineering in *Software and Knowledge*

Common Core Department

Mathematics

MP10 scientific reasoning

Attended on A2003, result B

This course aims to help students develop their scientific reasoning, to propose hypotheses, to choose and act on problem solving processes, to solve problems, and to analyze and critically consider the results. Students will first complete and reinforce their basic knowledge in mathematics. They will then use and apply this knowledge to rigorously formulate physical or technological laws and observations.

The curriculum focuses on 6 themes:

- derivatives and differentials, analytical and vector geometry,
- sinusoidal magnitudes,
- complex numbers,
- differential equations with constant coefficients and series,
- logarithms,
- exponentials and standard functions.

MT11 basics of algebra and calculus

Attended on A2003, result E

This course has three objectives: to reinforce previous knowledge, to teach rigorous reasoning, and to introduce fundamental elements of algebra and calculus.

Topics covered include:

- real and complex numbers,
- structures,
- polynomials,
- rings ($K[x]$, $+$, \times), degree,
- valuation, ($K = k$ or C),
- series of real or complex numbers,
- numerical functions of real variables,
- vector spaces and matrixes.

MT12 integration - linear algebra - functions of several variables

Attended on S2004, result C

This course has three objectives: Theory and techniques of integration, matrix algebra, basics of functions with several variables.

The following topics and sub-topics will be considered:

- Linear algebra: linear applications $L(E,F)$, determinants, reduction of endomorphisms
- Integration: Functions defined by an integral, integration of continuous functions of segments, calculation of primitives, general integrals.
- Differential equations: defining a solution, maximal solutions, differential equations of the 1st order, differential linear equations of the 2nd order, differential systems of linear equations of the 2nd and 3rd order, functions of R^n in R^p .

MT25 applications of algebra and geometry analysis

Attended on A2004, result D

The objectives of this course are to provide the basic skills of plane and space geometry for engineers. Parameterized plane curves. Curves defined by polar equations. Calculation of multiple integrals. Real prehilbertian spaces. Bilinear shapes. Quadratic shapes. Endomorphisms specific to Euclidean spaces. Vector fields. Applications of multiple integral calculations. Conics. Quadratics. Curves in 3-D space. Surfaces - Parameterized layers.

SQ20 statistics and probability

Attended on S2005, result B

The goal of this UV is to familiarize students with the notion of randomness and to enable them to manipulate probability calculations of varying degrees of complexity. The following topics are examined: axiom of probability, random variables; probability distributions, conditional probability, moments, characteristic functions of one random variable, the study of particular laws such as: Gauss, exponential, binomial or Poisson. The study of two random variables; joint distribution of two random variables. Sequence of random variables, central limit theorem.

Physics

PS11 material mechanics and geometrical optics

Attended on A2003, result C

PS11 is a basic course in mechanics and geometrical optics. Mechanical concepts tackled in the course are basic concepts useful for students wishing to follow more specialised courses in mechanics. In optics, emphasis is placed on geometrical optics with the aim of understanding the principles of simple optical apparatus. Main topics are the mechanics of materials (kinetics, dynamical and energetic studies, examples of simple mechanical movements), geometrical optics (fundamentals, optical systems, image formation), spherical mirrors and dioptric systems, lenses, and applications for standard optical instruments.

PS12 measurement and electricity

Attended on A2003, result B

The aim of this unit is firstly to have students understand what a physical measurement is, and then to study basic electrostatic, magneto-static and electrical circuit phenomena. The following topics and sub-topics will be considered:

- Measurement: methods of physics,

physical dimensions, units, measurements, errors and uncertainties, graphical presentation of experimental results.

- Static electromagnetism: Coulomb's force, electrostatic fields and potentials, conductors in equilibrium, capacitors, electrical currents, magnetic fields, effect of a magnetic field on a charge and on a circuit, calculation of magnetic fields.

- Electrical circuits: generalities (conductors, insulators), electrical circuits, the various types of electrical currents, general laws of electrical circuits, dipole, electrical system analysis (Thévenin, Norton, superposition, etc.), energetic aspects.

PS27 thermodynamics

Attended on A2004, result A

The aim of this UV is to present an overview of thermodynamics. In addition to the theoretical approach, some practical examples based on the function of thermal engines are given.

Topics covered include:

- Principles and properties of thermodynamics,
- Fluid thermodynamics,
- Change of state,
- Thermal engines,
- Energetic approaches to the analysis of thermodynamic systems.

Chemistry

CM11 general chemistry

Attended on S2004, result D

The purpose of this course is to describe the basic concepts of general chemistry: the structure of atoms and molecules, ionic equilibrium, oxido-reduction kinetics.

The following topics and sub-topics will be considered:

- Atomic theory: atomic structure, the hydrogen atom, polyelectronic atoms, the Periodic Table of the Elements, atomic bonds and the geometry of molecules.
- Ionic equilibrium: aqueous solutions, solution-solvent interactions, acids and bases, pH complexation and dissolution equilibrium.
- Oxido-reduction: oxidation degrees, electrode potentials.
- Kinetics: reactions speeds, sequencing, thermal activation.

CM22 organic chemistry and environment

Attended on S2005, result A

The aim of this course is to present lectures relative to organic chemistry and environmental engineering. The first part of this course deals with the structure and

reactivity of organic compounds: stereochemistry, isometry, reactivity, nomenclature, and hydrocarbon structures. Throughout the second part, basic operations for recycling or processing of materials at the end of their useful life will be presented.

Computer science

LO10 introduction to microcomputers

Attended on S2004, result B

The aim of this unit is to allow students to master the basic use of a microcomputer. The topics studied will include the main elements of a microcomputer, use of peripheral devices and various instruments, and application software. The practical part of the course is carried out on microcomputers running Microsoft's Windows, Office word-processing and Excel spreadsheeting applications (includes VisualBasic programming).

LO11 algorithms and programming level I

Attended on S2004, result C

This UV is an introduction to computer science. There are two objectives: to familiarise students with the use of computers, and to begin learning how to program. Towards these ends, students will use the C language to resolve a series of problems, some of which are taken from other UTBM courses. Some of these problems will provide the basis for projects to be developed later.

LO21 algorithms and programming : level II

Attended on A2004, result A

This course aims to present the fundamental concepts of algorithms and programming. The emphasis is put on the algorithm building process. After a brief recap of static data structures, this course will present dynamic data structures, lists, files and related algorithms. Recursiveness will then be studied. Finally, students will be introduced to basic compiling concepts (lexical syntax, automata and analysis, etc.). Applications are programmed in C.

Project : Evaluation of an n-order polynome's string, m-time derivation and result's display.

LO22 Unix system initiation and C programming

Attended on S2005, result B

The aim of this unit is to introduce students, on the one hand, to the basic principles of operating multi-task and multi-user systems through the presentation of the UNIX system, and on the other hand, to the C language. The first part of the unit introduces a description of the system from the point of view of the user (basic behaviour) covering the main characteristics, the general organisation of processes and files, and the main commands. The second part studies the

necessary elements for C programming. We will consider different data types, control structures and structural programming.

Project : ncurses configuration tool based on bash scripts.

Electronics

EL20 analog electronics

Attended on A2004, result A

This course aims to provide students with the basics of electronics. First, students will acquire fundamental knowledge to begin the study of electrical circuits (fundamental theorems, circuits in transitory and harmonic flow rates). The analysis tools used in electronics are also introduced (Laplace transforms). In the second part of the course, students will learn about electronic components and their applications (diodes, transistors, linear integrated amplifiers, etc.).

Lab work goes hand in hand with lectures and allows students to acquire the necessary skills to implement electronic components.

Computer Engineering Department

Databases

BD40 information systems

Attended on S2006, result C

The subject of this course is the design of information systems and their construction. After an introduction of the central role of the data organization in the various branches of human activity, one presents a design method of information systems (MERISE) and the "entity association model" on real case studies. The standardization of the databases is approached from the point of view of improvement of the performances. A second part relates to data bases construction techniques: representation of the data in internal memory and mass memory, study of the various algorithms of access the data, with an analysis of their complexity and encountered difficulties. The course involves lab work and a mini project using MS-ACCESS.

Project : Wine cellar database using Access and Visual Basic.

BD50 data base design

Attended on S2008, result A

The databases are an essential part of computer system applications. The object of this module is to present the state of the art in data bases, the methods and techniques for designing, implementing and using databases. Definition and uses of databases; functionality and architecture of the data base management systems; models; relational model and languages; normalization theory; request optimization; concurrence and reliability, deductive and object oriented databases. This knowledge is used with the Oracle database software using SQL and PL/SQL languages. Students also learn how to tune physical storage model to increase efficiency with Oracle DB engine.

Project : Flight ticket booking website of an airwaves company. Oracle database have been setup using a personal computer. Best project of the semester.

LO51 data base and operating system administration

Attended on S2008, result A

The aim of this course is to allow users with a good knowledge of operating systems and Oracle database to acquire the necessary level to fulfill the duties of an administrator. On one hand, this course will be based on actual case-studies and will put the stress on the practical competence that an administrator should have, particularly regarding the configuration and interconnection of machines, and platform supervision and security (DNS, DHCP, LDAP and yellow pages servers, NFS storage, Samba, etc). On the other hand the course is focused on Oracle installation and

administration : client and server installation, middleware configuration, database creation, physical storage and security tuning, transaction and locks, logical and physical backups and rollbacks.

Artificial Intelligence

IA41 artificial intelligence : representation

Followed A2006, result C

This course gives a first introduction to artificial intelligence. Main emphasis is on knowledge representation. Both the practical and more fundamental points of views are considered. The course aims at giving the student a fairly advanced level in functional and logic programming, mainly through the two most important artificial intelligence programming languages : LISP and Prolog.

The course also contains an introduction to λ -calculus, inference engine, knowledge-based systems (KBS) and graphs search strategies.

IA54 Multi Agent Systems (MAS) and distributed artificial intelligence

Attended on A2008, result A

This course introduces the multi agent paradigm and the main technics of coordination and cooperation among intelligent agents. Agent oriented software engineering is first taught and then are introduced Ontologies and Speech Acts. The course presents two approach: reactive (boids and ants colonies) and cognitive agents. Several architectures used in agents design are taught (planification and action selection architectures). SMA simulation designing issues are also shown.

Project : Wireless Sensors Network simulator using SMA paradigm.

Programmation languages

LO41 architecture and use of operating systems

Attended on S2007, result D

This course presents the main elements of operating systems and their architectural interrelationships. The course gives a practical view of the use of operating systems through consideration of standard tools: compilers, linkers and system libraries. It also explains the relationships between operating systems and hardware features that support them. Supervised work will provide an introduction to UNIX system programming, including routines for calling system libraries. Practical work allows students to study the UNIX system shell, and to use the system library routines to control processes.

Project : highly threaded mapping software in C.

LO43 fundamental bases of object oriented programming

Attended on A2006, result C

This course presents a complete survey of the concepts of object-oriented

programming : data type abstraction, encapsulation, inheritance, abstract classes... We first focus on the theoretical basis of algebraic data type specification and then introduce the concept of encapsulation in the C++ language. The concepts of inheritance and aggregation, polymorphism and abstract classes are presented with great details. The focus is on the design of efficient object-oriented programs. The Java Language is presented and object design patterns are used to illustrate how to program with components. Then, we place the emphasis on object-oriented analysis and present UML methodology.

Project : Graphical production line simulator in Java.

Algorithms

AG41 optimization and operational research

Attended on S2007, result B

The course focuses on the basic techniques used in resolving problems of optimization, and as such includes study of the methodological aspects of optimization and of the standard programming tools used in resolution. Subjects covered includes linear programming (simplex), integer programming using tree search, dynamic programming, heuristic methods, tabou search, genetic algorithms, ants colony and game theory.

Project : Timetable optimization software using genetic algorithm.

Software design

GL52 software engineering

Attended on S2008, result B

This course aims to go over the principles, techniques and methods of software development. It clarifies the objectives of software engineering and its fundamental principles and it presents design specification methods: formal specifications, SADT, SA, UML, HOOD, top-down design, object oriented design. The programming part of the class rests on Java, which constitutes the support allowing the implementation of specification and design examples. Finally, we will go over the environments and software tools facilitating development. B and Z languages are also introduced.

Microprocessors architectures

MI41 logical circuits and microprocessors

Attended on A2006, result B

The aim of this course is to introduce the basic concepts needed to understand how logical programmable systems do work, especially microprocessors. After a review of numeration systems, information coding and Boolean algebra we focus on the combinatory circuits and their applications (coding, decoding, arithmetical and logical operations...). We then describe the sequential circuits and their applications

(flip-flops, registers, counters, memories...). The internal architecture of a standard processor is exposed (bus, alu, command and control units, microprogramming, coding and sequencing of instructions...). A whole system built around such a processor is presented. Practical lessons involve Altera FPGA and VHDL programming.

MI43 microprocessors (basic interfacing and software)

Attended on S2007, result A

This UV aims at introducing the use of microprocessors within the context of a given system. Teaching is based on the study of the ARM7 RISC processor: processor interface, memory organization (caches, SDRAM, device bus), MMU (memory management unit), interruptions and OS multi task simulation.

Networks

RE41 computer networks

Attended on S2007, result A

The goal of this UV is to give the student an understanding of the network administration, and of the set-up and launching of local and public network systems. The student will focus on business applications, considering the software and hardware necessary to construct a network (cabling, routing, supervision, diagnostics). We will also consider the different software and systems facilitating access to different layers of computer network services.

RE56 mobile networks

Attended on S2008, result B

The aim of this course is to present the different mobile services used around the world. The course goes deeper on the widely used GSM protocol and its upgrade UMTS. Frequency assignement, electromagnetic waves, mobile services (like speech and data), radio interface, network design (base stations locations).

Project : GSM Frequency hopping simulator in C#.

Web

IN42 online and offline multimedia

Attended on S2007, result A

When this course is completed, the student will be able to design online or offline Hypermedia software.

This class will deal with:

- audio, image and video file formats, color encodings, compression methods, and media synchronization,
- the use of multimedia design tools (Flash and ActionScript, Director and Logo)
- standards, protocols and implementation of XML and XHTML.
- automatic text indexation (Google PageRank algorithm)

Project : Interactive and animated story/game for kids using Flash and vectorial pictures created with Illustrator.

Statistics

SQ40 statistical methods for engineers

Attended on A2006, result A

This course presents basic methods for statistical inference. It is applying to students, engineers, researchers who have to process random data from measures or analyses.

Firstly, point and interval estimation methods are presented.

After, this is a general presentation of hypothesis tests, illustrated by some examples of parametric tests, non-parametric tests and goodness of fit tests.

Finally the last chapters presents the analysis of variance and the linear regression.

Humanities Department

Languages

LE02 English level II

Attended on S2004, result C

This course has been created for the low and upper - intermediate levels. It is meant to help the students to acquire autonomy in expression (oral and written). It puts the stress upon every day life situations. We use video, tapes and articles from the press to talk about all the non-professional situations, which the students might have to face in an English speaking environment. The situations are always related to the professional environment.

LE03 practical English and "TOEIC"

Attended on A2005, result C

Students need to pass this course to receive their engineering diploma. This course is a prerequisite for higher level English courses. To reach the objectives of the class, students will work on their oral and written comprehension, and their oral and written expression. We will focus on oral exercises and practice, and report writing.

This course is divided into three parts:

- 2 hours of SE devoted to improving the students' skills for oral and written communication;
- 1.5 hours of LW devoted to oral communication
- 1 hour of SE devoted to the preparation of TOEIC (an international exam recommended to obtain the engineering diploma)

This additional hour may be optional if students have already obtained the TOEIC or an equivalent.

LG01 German level I

Attended on A2006, result C

This module is designed for beginners with some knowledge wishing to improve their German as well as for students who have already studied German for less than three years in secondary school. The rapid progression of the course requires a real commitment from each student. Teaching is essentially based on a large amount of review, in-depth study of the structures of

the language and also on a broadening of vocabulary.

LG02 German level II

Attended on S2007, result C

This module is designed for students who have got a good basis in German, either a LG01 level or an average school knowledge (from 3 to 6 years). This module prepares for LG03. With oral supports, written documents and some video reports, this module should enable students to express themselves in an accurate way and to react efficiently in many daily life situations in a German speaking country. Students will be asked to give their own opinion and to justify it.

LJ00 Japanese for beginners

Attended on S2008, result A

This course is intend to initiate students to the japanese language and culture.

- form of address
- numbers, years, months, days and hours.
- simple questions and how to answer
- daily life communication
- verb tenses, adjectives, polite and neutral verb form (affirmative)
- understand short texts
- produce short sentences and writing them using japanese writings on computers.

The aim of this course is not to pass the fourth-level Japanese Language Proficiency Test but students could pass it after this course.

Social Sciences

AR01 art and society

Attended on A2003, result D

This course is not a lecture in the history of art. Its purpose is to link the art phenomenon to the ambitions, the cravings, the obsessive fears of a society or a social group at a particular time in history. It will aim especially at providing future engineers with intellectual means which will enable them to apprehend better the relations between sciences, techniques and the different forms of artistic expression. This study will give illustrations, particularly through commenting upon works of art in architecture, painting and photography.

AR04 numeric technologies, artistic creation and cultural engineering

Attended on A2006, result E

This course aims to familiarize students with the use of numeric technologies in cultural and artistic domains.

This course will allow students to discover the main lines of research and the most innovative practices in the fields of video creation, interactive devices, multimedia installations and electronic communication networks.

This course will give students the opportunity to meet French and international artists, and cultural engineers (visits to workshops, exhibitions with comments and presentations based on

concrete examples).

Presentation : Mark Rothko abstract paintings

EC01 foundations of economics

Attended on S2004, result E

EC01 is primarily directed to first and second year (TC) students, as well as third year (beginning "Branches") students.

It is necessary for an engineering student to have a basic economic understanding if he/she wants to interact with different partners of a company and its global environment. Moreover, the double understanding - the scientific and technical knowledge on the one hand, and the knowledge of economics and management on the other hand - is more and more vital in order to gain positions of responsibility. EC01 aims to develop this economic knowledge. Consequently, after presenting the foundations of economic analysis (the main economic ideas, methods and tools) in order to introduce the logic of economic reasoning, this course intends to cover the main economic functions (production, consumption, saving, investment...), the coordination mechanisms of activities (the market, organization), currency and methods of economic financing, the role of the State and its economic intervention (currency, budget and employment policies). Classes (SE) focus on the study of documents and concrete cases in relation to the different themes dealt with in lectures (L).

DR05 author rights in computer science

Attended on S2007, result C

First of all the aim of the course is to make students aware of protection rights. Thus, the course will be more specifically focused on the relationship between the engineer and its creation in computer science. In this way, the author right will be mainly studied. But, other forms of protection will also be tackled such as patent rights. The course will be based on a theoretical and practical approach combining doctrine and jurisprudence. A jurisprudence study allowing the analysis of concrete examples.

SI02 Semiology of the still image

Attended on S2008, result B

We communicate through speech, through writing and through many other natural languages. Semiology is the study of these languages : graphic art, photography, painting, body movements, cinema, video, etc. The aim of these UV is to offer students a method for analyzing visual messages and to emphasise still pictures as a means of conscious communication. A theoretical approach to symbolic systems and semiological analysis is applied to pictures in advertising, propaganda, news information, art and other forms of communication. Based on current scientific research, this approach deals primarily with the processes of communication, the

psychology of visual perception, the sociology of communication, and a little bit of psychoanalysis.

Presentation : Impressionism

SP01 management of physical life

Attended on A2004, result E

This course aims at taking over the knowledge concerning the upkeep or the development of physical resources through bodily practice.

The study deals with: the relationship between human structure and the use of energy in the context of a physical activity or of movement, that is to say the study of the systems of the supplying and return of energy.

- The analysis of the effect of a moderate or intense practice.
- The characteristics of social practice.

Acquisition of practical knowledge in the context of tutorial class. This course is validated after a written test and a written activity report.

Presentation : Tiredness mecanisms

EE05 cultural behaviour and human relationships in international contexts

Attended on A2008, result D

The aim of this UV is to make students aware of the realities of different international situations in North and South America, Northern and Southern Africa, the Middle East and Far Eastern countries. During this UV, several experienced speakers in international cooperation, intercultural management and international socio-economic development will share their experience in the field. A case study carried out in groups will allow students to increase their understandings of cultural behaviour and human relationships in intercultural contexts.

Presentation : The emancipation of the chinese women

PH04 philosophy and computer science

Attended on A2008, result B

The goal of this course is to discover the tight link between philosophy and computers. The first part is about computer's history and philosophical issues encountered during the IA developpements (Turing test, philisophical criticizes to IA supposed limitations). Computer science prehistory in the 17th and 18th century when smartness became computation.

Presentation : the last defenders of strong IA.

Project

TN10 project realisation

Attended on A2003, result C

The aim of this course is to develop the students' sense of initiative and responsibility.

Different subjects such as the construction of simple apparatus for laboratories, the design of models, conducting surveys, development projects are suggested by

university staff. These subjects lead students to establish contacts, collect documents, make invoice estimates, decide on the methods for the realization of the project, present a timetable and discover different techniques.

Project : Museum signs design and build

Internships

ST10 technical internship

Attended on A2003, result C

With the aim of developing contacts with the professional world during their training as an engineer, students are required to undertake a training course for one month at the end of their first term of Common Core studies.

Integrated into the academic calendar, and validated as a UV, the aim of this training course is to give students first-hand experience of professional life. Students hold posts and participate in real tasks, develop their ability to communicate by writing reports setting the task in its context and giving personal evaluations, and by giving oral presentations.

The nature of these training courses is varied, but always constitutes a productive and direct involvement for students in real decision-making processes. The establishments involved in these placements normally employ upwards of 50 people.

Internship : NSC (Nicolas Schlumberger Company) the world leader textil machines factory.

ST40 long term professional internship

Attended on A2007, result B

This period of work in an industrial environment, public or private, lasts for one semester. It takes place during the third semester of Branch studies. The placements are in production departments, or closely related to production, such as fabrication, quality control, research and development, maintenance, drawing office, etc. The subject of the placement offered by industry is ratified by the university. The distribution of placements takes into account the abilities and interests of the students. The work carried out is detailed by the student in a written report and an oral presentation.

Internship : EuroAirport (Basel-Mulhouse airport) the seventh french airport.