École nationale
supérieure
d'informatique
pour l'industrie
et l'entreprise

ensiie
PARIS - ÉVRY

AT THE HEART OF CONTEMPORARY CHALLENGES

COURSE CATALOGUE 2017

École associée de
INSTITUT
Mines-Télécom

université
PARIS-SACLAY

A WORD FROM THE DIRECTOR

The École Nationale Supérieure d'Informatique pour l'Industrie et l'Entreprise is one of the oldest institutions offering a degree in computer engineering. Since its creation in 1968, almost 3,000 engineers have graduated from this institution.

ENSIIE is a public institution under the supervision of the Ministry of Higher Education and Research, and is a member of the Conférence des Grandes Écoles (CGE). The degree is recognised by the Commission des Titres d'Ingénieurs (CTI).

The ENSIIE program, with its threefold curriculum on IT, mathematics and business organization, is valued and recognized within the business world. Our graduates are working in all sectors of economic activity, where IT and organization are a major driver of development and business innovation.

ENSIIE provides diversified and high-quality training that students can follow either on our campuses or on exchange with our academic partners in France and throughout the world. This is complemented by a strong emphasis on workplace experience, with over 11 months of internships and a constant focus on research and innovation.

Admission is based on competitive entrance exams or on qualifications. Students can choose to follow courses in Évry, just south of Paris or, since September 2009, in Strasbourg in the east of France.

The institution offers engineering qualifications for students, for workers via block-release training and continuing education, as well as a choice of complementary qualifications. In 2011, ENSIIE became an Institut Telecom partner institution which enabled us to offer a wider selection of programs to our students.

Useful and necessary for engineering training, extracurricular activities are strongly encouraged at ENSIIE via around 40 cultural and sporting student societies. Extracurricular activities promote a feeling of camaraderie and cooperation between students which contribute to the development of social competencies and interpersonal skills.

***Ménad Sidahmed**, ENSIIE Director*

PROGRAM ORGANIZATION

The engineer program is a 3-year program that delivers the "Ingénieur de l'ENSIIE" degree. Each academic year is made of two semesters: fall semester (September to January) and spring semester (February to May). Our multidisciplinary program puts a strong emphasis on *Mathematics* (optimization, probability, statistics), *Computer Science* (programming, information technology) and *Business Organization* (Finance, Management). Beyond a general background in mathematics and informatics, the students choose one of the 7 specialties developed in our program. We propose 3 specialties in mathematics: *Operations Research, Mathematical Finance, Statistics and Data Science*, and 4 specialties in informatics: *Security, Video Games and Interactions, Big Data, Engineering Software*.

1ST YEAR

Semesters 1 and 2 give the scientific and technical basis in mathematics; computer science and business organization needed for the advanced courses in years 2 and 3. All the courses are compulsory and the students follow 6 technical teaching units (42 hours, 4 ECTS, *European Credit Transfer System*) and 2 teaching units in *Foreign Languages and Business Organization* (45 hours, 3 ECTS). Each semester is validated with 30 ECTS.

2ND YEAR

During semesters 3 and 4, the students select 6 technical teaching units among the possible options proposed in their field of interest (each technical unit is 4 ECTS). They follow 2 compulsory teaching units in *Foreign Languages and Business Organization* (3 ECTS). Each semester is validated with 30 ECTS.

3RD YEAR

Semester 5 is the last semester with courses taught by recognized researchers and professionals. The courses correspond to a research master level. The students select 5 technical teaching units (5 ECTS) among the possible options and 2 compulsory teaching units in *Management and Business* (2.5 ECTS each). The semester is validated with 30 ECTS.

Semester 6 is the "Engineer Project" and consists in a 6-month training period in a business company or in a research lab (academic or not) in the field of specialty. The semester 6 is validated after the defense of the final dissertation (30 ECTS).

TRAINING PERIODS

Before the Engineer Project in semester 6, the students must complete 2 training periods after the first and second academic years. Each training period is about 2 – 3 months (between June and September) and can be done in a company or in a lab, with a view to developing technical and professional skills. Each training period is accounted for in a dissertation and a defense, and is worth by 8 ECTS.

DOUBLE DEGREES

IN MATHEMATICS, COMPUTER SCIENCE AND ELECTRICAL ENGINEERING

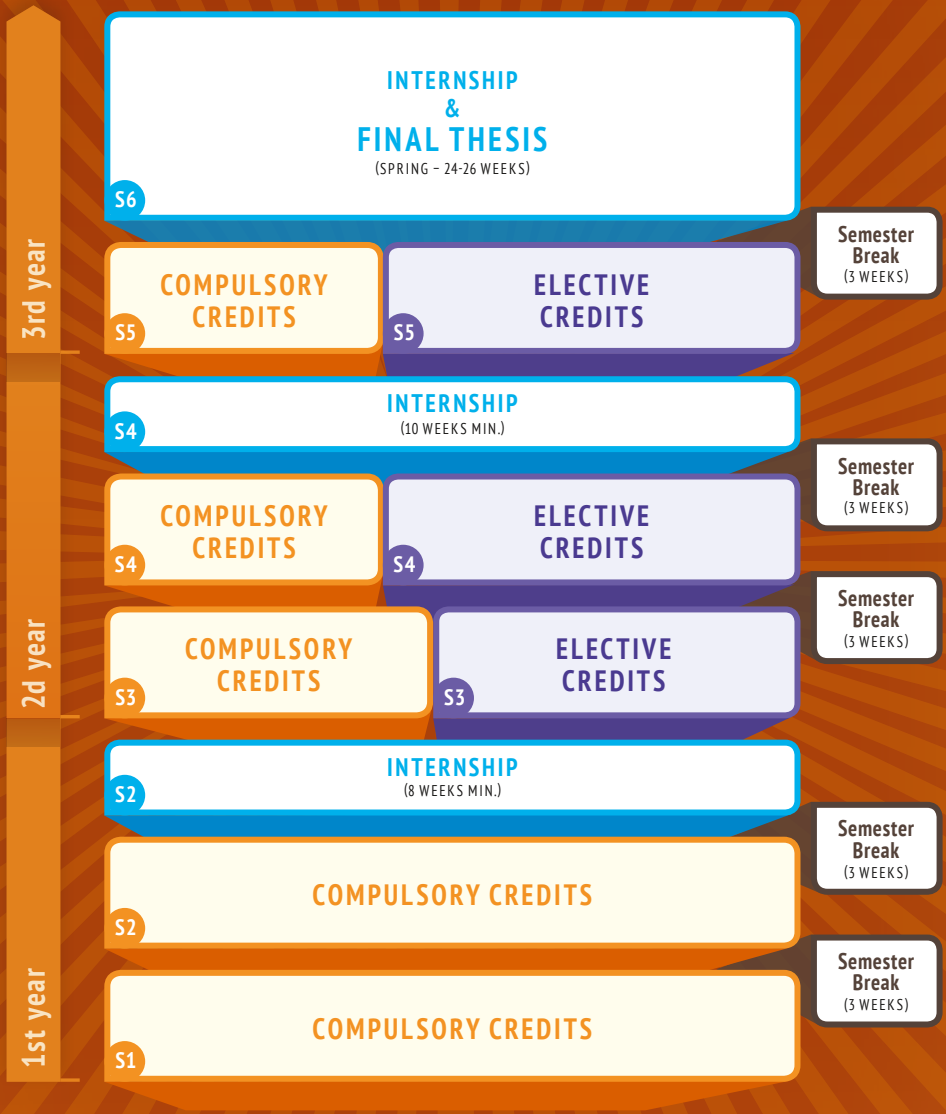
ENSIIE has strong relationships in research and teaching with Paris-Saclay University (UPSay) and Évry University (UEVE). In particular, the professors, researchers and PhD students of ENSIIE work in the following labs: *Laboratoire de Mathématiques et Applications d'Évry* (LaMME), UEVE, (UMR CNRS 8071) and *Laboratoire des Sciences de l'Ingénieur, de l'Informatique et de l'Imagerie* (Icube), UdS, (UMR CNRS 7357). Moreover, the students following the Engineering Program can be enrolled at the same time in programs with our partners.

During the first year, the students can get a Bachelor degree in Mathematics with Université d'Évry (Université Paris Saclay) by attending two additional teaching units in mathematics.

During the second year, the students can follow a Master (1st year) in Applied Mathematics (in Évry) or in Computer Science (in Strasbourg) by attending complementary courses.

During the third year, the students can be enrolled in a Master (2nd year) in applied mathematics, computer science or electrical engineering, by attending selected courses from the engineer and master programs. The "Engineer Project" is then common with the Master's Thesis. When all the requirements are fullfilled, the students earn the Engineer degree and one of the following masters:

- Master "**Mathematics and Applications**"
  of Paris-Saclay University
  Specialty "Financial Engineering" (IIF)
  Specialty "Statistical Engineering and Genomics" (ISG)
- Master "**Computer Science**"
  of Paris-Saclay University
  Specialty "Operations Research" (MPRO)
  Specialty "Machine Learning, Information and Content" (AIC)
  Specialty "Data Management in a Digital World" (DataScale)
  Specialty "Foundations of Computer Science and Software Engineering" (FIIL)
  Specialty "Conception et Intelligence des Logiciels et Systèmes" (CILS)
- Master "**Electrical Engineering**"
  of Paris-Saclay University
  Specialty "Information Processing and Data Exploitation" (TRIED)
  Specialty "Virtual Reality and Intelligent Systems" (RVSI)



6-SEMESTER PROGRAM OF STUDY

COURSE CATALOGUE
ACADEMIC YEAR 2017–2018



RESEARCH AT ENSIIE

Most of the professors at ENSIIE are academic researchers, active in their own research fields in computer science and applied mathematics. They are members of our joint research lab:

– LaMME (Mathematics – with Université d'Évry and CNRS) Laboratory of Mathematics and Modeling of Évry;

or of our partner laboratories:

– SAMOVAR (Computer Science – Telecom SudParis and CNRS), Services répartties, Architectures, Modélisation, Validation, Administration des Réseaux;

– IBISC (Computer Science and Electric Engineering – Université d'Évry), Informatique, Biologie Intégrative et Systèmes Complexes;

– ICUBE (Computer Science and Electric Engineering – Université de Strasbourg - CNRS), laboratoire des sciences de l'Ingénieur, de l'Informatique et de l'Imagerie, UMR CNRS 7357, Université de Strasbourg;

– LIMSI (Computer Science and Electric Engineering – CNRS, Université de Paris Sud), laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur.

As active researchers, they introduce our engineering students to advanced research topics, and research methodology through high-level courses, research projects, and training periods in research labs (1rst, 2Nd or in the 3rd year for the final thesis). Moreover, research studies are strongly encouraged in 3rd year by being enrolled in one of our Research Master Programs (within University Paris Saclay), and by pursuing a PhD program in computer science or mathematics (for instance, within EDMH – Doctoral School in Mathematics Hadamard).

MSC IN APPLIED MATHEMATICS

ENGLISH-TAUGHT MASTER'S DEGREE IN APPLIED MATHEMATICS GRANTED BY ENSIIE

This one-year Applied MSc programme starts in the autumn semester and is designed to steer your career towards the mathematics jobs that are in high demand across all industries. The syllabus combines rigorous mathematics with practical experience: you will learn to develop computational methods and apply them to model, study and solve interdisciplinary problems.

PROGRAM INFORMATION

The program consists of 60 ECTS credits in Semesters 1 and 2. It also includes a full-time internship in the spring. Please bear in mind that course offerings and availability are subject to change as curriculum develops to reflect a modern degree program. This Applied Mathematics MSc program is offered on a full-time basis on our campus in Évry. All teaching is carried out in English and classes are scheduled from the beginning of September to the beginning of April.

In this Applied MSc program, you will:

– acquire fundamental tools that will allow you to follow advanced courses in Applied Mathematics;

– become familiar with a mathematical approach to real-world industrial problems.

ELIGIBILITY

Entry requirements: to be eligible for a place on the Applied Mathematics MSc you must have at least an upper second class degree, or its equivalent, in a numerate discipline such as (but not limited to) mathematics, engineering, computer sciences. Previous study of applied mathematics, probability and differential equations at university level is required. Previous programming experience, including the use of computer programming in university-level studies, is also required.

MATHEMATICAL SKILLS

To succeed in this Master's degree and enjoy its content, you need a strong mathematical beckground: an aptitude for mathematics is required and has to be evidenced by university-level credits you have earned in Statistics, Mathematical Optimisation, Analysis, Differential Equations and Probability.

ENGLISH SKILLS

If your first language is not English or your first degree is not from a British or US University, you will need to provide evidence of your ability at spoken and written English.

COMPUTING SKILLS

It is important for an Applied Mathematics practitioner to be able to use computers fluently to model and analyse new problems. This will involve programming in a high-level language. Applicants should have the following as part of an earlier degree: an undergraduate programming course (in any language e.g. R, MATLAB, C, C++, Fortran, Python); an understanding of flow control; the ability to use methods / functions.

COST OF STUDYING AT ENSIIE

Approximately € 1,500 per student. The French government provides substantial funding for higher education, which is why ENSIIE students enjoy low tuition fees.

CORE MODULES TAUGHT IN ENGLISH

SEMESTER 1

The first semester is composed of all the following modules. The compulsory courses will build strong applied mathematical and computational foundations.

DISCRETE TIME STOCHASTIC PROCESSES S3-[PST]

The objective of this Unit is to study the discrete time stochastic processes, Martingales and Markov chains in particular.

DATA ANALYSIS S3-[MAD]

Data analysis is a powerful tool defined as the process of extracting data, analyzing it from many dimensions, exploring large complex data sets, including those in very large databases, producing a summary of the information in a useful form that identifies relationships within the data.

OPERATIONS RESEARCH S3-[MRO]

Operations Research (OR) is one of the main areas of application of computers in the industry. It includes a set of methods, conceptual models and tools to streamline and optimize the architecture and operation of complex systems (production, network, transport, etc.), technical or techno-economic choice regarding products and, generally, the process of decision-making in a company.

REGULARISED REGRESSION S3-[MLG]

The course presents the theoretical and practical elements of regression models that are more sophisticated than the linear model. It aims to provide tools for predicting data as well as approaches that take non-linearities into account.

SEMESTER 2

The second semester is also composed of compulsory courses, building on the skills gained in Semester 1.

MODELING AND SIMULATION S4-[MESIM]

The training course introduces students to the simulation methods used in statistics, especially in Bayesian statistics, maximisation methods and quadrature computations in high dimensions which are necessary to deal with complex models used in fields like econometrics, finance, genetics, ecology or physics.

STATISTICAL MODELING S4-[MOST]

This course teaches a set of methods used for identifying the existing relationship between the response and the variables of a random phenomenon. Focusing on supervised classification and regression, the syllabus includes the various ssues of modeling (analysis and / or prediction of a phenomenon).

FINANCIAL INSTRUMENTS AND MODELS S4- [IMF]

The goal of this course is to present the basic concepts in mathematical finance, with a focus on the mathematical approach (discrete case) and the financial market approach.

OPERATIONS RESEARCH: TOOLS AND COMPLEMENTS S4- [CORO]

The objective of this course is to further develop students' knowledge in linear programming by giving them the opportunity to model problems, implement methods and use mathematical programming software.

STOCHASTIC CALCULUS S4- [MCS]

This course introduces fundamental mathematical concepts that are applied in many fields, especially in economics and finance. For instance, stochastic calculus is widely used for portfolio management, pricing and hedging derivatives. This module is essential for students who wish to work in finance and financial engineering.

ANALYSIS OF PARTIAL DIFFERENTIAL EQUATIONS (PDES) S4-[ANEDP]

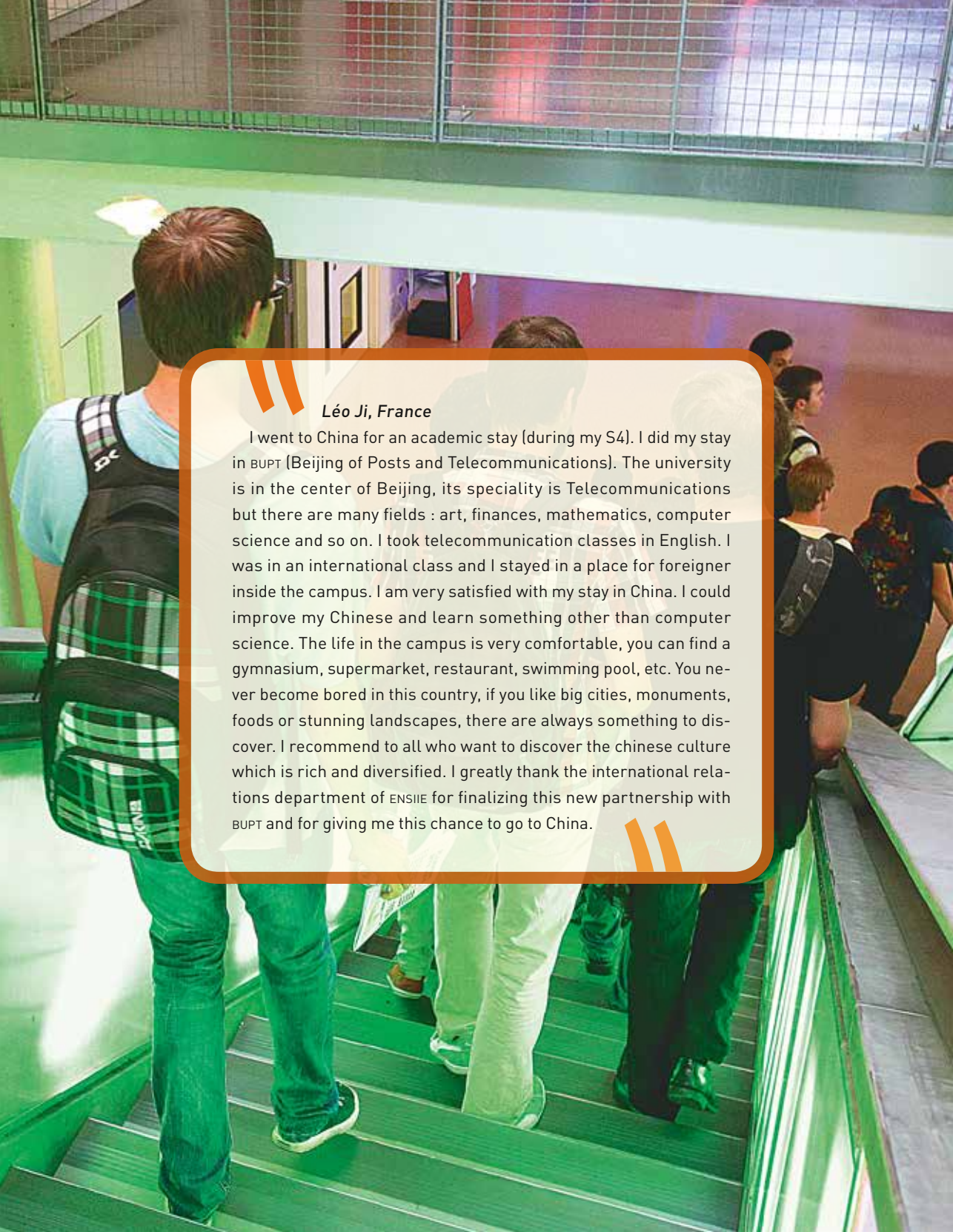
The first part is a theoretical course for solving Partial Differential Equations with abstract existence theorem (Lax-Milgram). The second course is about the finite element methods for computing numerical solutions to PDEs.

CREATIVE CODING S4-[CC]

Discover the artistic creative processes linked to the digital world and explore the various dynamics that develop between engineers and artists. This course entails a creative use of IT tools.

CONCEPTION OF A DIGITAL PIECE OF ART S4- [ANU]

A creative approach to IT concepts and tools (Arduino, 3D printer, salvage, etc.). Investigate the new relationships that develop between engineers and artists, and give your IT skills a creative spin.



Léo Ji, France

I went to China for an academic stay (during my S4). I did my stay in BUPT (Beijing of Posts and Telecommunications). The university is in the center of Beijing, its speciality is Telecommunications but there are many fields : art, finances, mathematics, computer science and so on. I took telecommunication classes in English. I was in an international class and I stayed in a place for foreigner inside the campus. I am very satisfied with my stay in China. I could improve my Chinese and learn something other than computer science. The life in the campus is very comfortable, you can find a gymnasium, supermarket, restaurant, swimming pool, etc. You never become bored in this country, if you like big cities, monuments, foods or stunning landscapes, there are always something to discover. I recommend to all who want to discover the chinese culture which is rich and diversified. I greatly thank the international relations department of ENSIIE for finalizing this new partnership with BUPT and for giving me this chance to go to China.

SEMESTER 1 S1

COMPULSORY COURSES

[LVFH1] FOREIGN LANGUAGES AND COMMUNICATION

PROFESSOR Laurence Bourard

MISSION AND CONTEXT Compulsory course

OBJECTIVES The Language modules are designed to help students engage in an increasingly globalized economy and to give them the means to expand their horizons. Students are offered an opportunity to further their spoken and written skills both in English and in another foreign language. The Communication module focuses on basic notions that will teach students to communicate effectively in the workplace. This course aims to increase their confidence by honing their interpersonal communicative skills.

PUBLIC Bachelor level

DURATION 45.5 hours

DIVISION
LVFH1-M1 – English as a Foreign Language
LVFH1-M2 – Foreign Language
LVFH1-M3 – Soft Skills in the Workplace

ECTS 3

COURSE TAUGHT IN Arabic – Chinese – English – French – German – Italian – Japanese – Portuguese – Russian – Spanish

[LVFH1-M1] ENGLISH

INSTRUCTOR Laurence Bourard

MISSION AND CONTEXT Compulsory course

OBJECTIVES Enabling students to improve their command of English. Helping them reach the B2 level or C1 level of the Common European Framework of Reference for Languages. Preparing them for a test that certifies their proficiency in the English language (TOEIC or BULATS for example).

PUBLIC Bachelor level

DURATION 17.5 hours

ORGANIZATION 10 sessions

CONTENT Classwork revolves around learner-centered activities based on authentic materials drawn from periodicals, audio/video resources and websites. Small-size groups allow students to develop their language abilities: listening, reading, speaking/interacting and writing skills.

EVALUATION (SESSION 1) 20% of the final mark: class attendance (more than 2 unexcused absences will result in a "0" score)
40%: continuous assessment (graded coursework)
40%: final examination

EVALUATION (SESSION 2) Depending on the number of students who are allowed to resit, the make-up exam will be either an oral or a written test

COURSE TAUGHT IN English

[LVFH1-M2] FOREIGN LANGUAGES

INSTRUCTOR Isabelle Malefant, Manuel Caldera Bracho, Alberto Suarez Rojas, Yi Starck, Yukiko Fargues, Janna Hermant, Rita Maubert, Christine Cracosky, Karine Bailly, Mahgol Salémi

MISSION AND CONTEXT Compulsory course

OBJECTIVES This module gives students an opportunity to hone their spoken and written skills in another foreign language. ENSIIE offers a choice of 9 language courses: Arabic, Chinese, French, German, Italian, Japanese, Portuguese, Russian, Spanish. The FSL course (French as a Second Language) is designed for international students.

PUBLIC Bachelor level

DURATION 17.5 hours

ORGANIZATION 10 sessions

CONTENT Authentic materials are used, from press articles to music, games and literature. Learners are to enhance their knowledge of the language they have chosen to study and also increase their level of cross-cultural awareness and international competence.

EVALUATION (SESSION 1) 20% of the final mark: class attendance (more than 2 unexcused absences will result in a ''0'' score)
40%: continuous assessment (graded coursework)
40%: final examination

EVALUATION (SESSION 2) Written Test

ECTS 3

DOCUMENTATION PROVIDED Press articles, music, games

COURSE TAUGHT IN Arabic – Chinese – French – German – Italian – Japanese – Portuguese – Russian – Spanish

[LVFH1-M3] SOFT SKILLS IN THE WORKPLACE

INSTRUCTOR Francine Attia, Laurence Faure, Catherine Lagarde

MISSION AND CONTEXT Compulsory course

OBJECTIVES The aim of this module is to teach communication skills and enable students to improve their interpersonal competence and confidence.

PUBLIC Bachelor level

DURATION 10.5 hours

ORGANIZATION 6 sessions

CONTENT
1. Introducing oneself;
2. Adapting to different situations;
3. Speaking in public. Presentation skills;
4. Writing a CV;
5. Writing an effective cover letter;
6. The art of persuasion: convincing and influencing others;
7. Conducting a job interview.

EVALUATION (SESSION 1) 20% of the final mark: class attendance
40%: continuous assessment (graded coursework)
40%: written examination
Two unexcused absences will result in a score of ''0'' for class attendance and students with more than two unexcused absences will receive a 50% deduction in their coursework grade.

EVALUATION (SESSION 2) There is no make-up exam session for this module

COURSE TAUGHT IN French

[ECO1] INTRODUCTION TO MICROECONOMICS

PROFESSOR Thomas Lim

MISSION AND CONTEXT Compulsory course

OBJECTIVES This course is an introductory undergraduate course that teaches the fundamentals of microeconomics. This is the first course that undergraduates take in economics. The objective of this course is to provide a thorough introduction to economic theory. Starting from the basic ideas of tradeoffs, opportunity cost, and the benefits of trade, we will study how the market forces of supply and demand cause prices to be what they are. We will see the sense in which market economies are efficient, and the way governments can make our economy less or more efficient. By the end of the course, you will be able to understand introductory microeconomic theory, solve basic microeconomic problems, and use these techniques to think about a number of policy questions relevant to the operation of the real economy.

PUBLIC Bachelor level

DURATION 45.5 hours

DIVISION ECO1-M1 – Civil and Banking Law
ECO1-M2 – Accounting and Financial Management
ECO1-M3 – Macroeconomics

ECTS 3

SUGGESTED READINGS
– Rittenberg,L., Tregarthen, T., *Principles of Microeconomics*, 2009;
– Perloff, J. M., *Microeconomics*, 5th ed. Addison Wesley, 2008.

COURSE TAUGHT IN French – English

[ECO1-M1] CIVIL AND BANKING LAW

INSTRUCTOR Dina de La Croix

MISSION AND CONTEXT Compulsory course

OBJECTIVES To develop the research competences in the legal information, study of legal sites such as Légifrance; the Justice department; Public services; INPI; CNIL... Investigate the legal documents and conduct jurisprudential investigations. To know the French legal system and to familiarise with the legal vocabulary.

PUBLIC Bachelor level

DURATION 10.5 hours

ORGANIZATION 5 sessions – Final Exam: 1 session

CONTENT
– The legal frames of banking activities;
– The banking files;
– The check – Consumption loans/credits;
– Housing loans;
– Account rights;
– The guarantees.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Lectures notes, useful articles

SUGGESTED READINGS
– Macey, J. R., Miller, G. P., Carnell, R. S., *Banking Law And Regulation*, Fifth Edition AspenLaw & Business Company, 2013.

COURSE TAUGHT IN French

[ECO1-M2] ACCOUNTING AND FINANCIAL MANAGEMENT

INSTRUCTOR Philippe Castelnau

MISSION AND CONTEXT Compulsory course

OBJECTIVES To present accounting as an information system to the future management technicians, who are to cooperate with the businesses' accounting services. A business, regardless its size, is an economic agent who doesn't do another thing but to consume the goods and services of certain economic agents and to produce goods and services to other agents. General accounting, precisely, is aimed to understand these flows, these movements of production and consumption. As accounting understands and treats the economic information, it must clearly adapt to the business' environment, the goals of the business and its lasting quality all of which are constantly under question. The French accounting laws evolve in an international context in course of transformation with the appearance of international norms, namely the IFRS. Accounting law is therefore adapted to be more reactive. The accounting laws applicable to yearly accounts of the businesses and remarkably of the PME have experienced a genuine revolution. Certain fundamentals of French accounting have been revised.

PUBLIC Bachelor level

DURATION 15.75 hours

ORGANIZATION 9 sessions

CONTENT 1. Accounting management: faithful image, fourth directive, norms, notion of patrimony, balance accounts, balances, management accounts, balance sheets, accounting organization, books, big books, balances; billing; inventory work; amortization, provisions, payable fees, receivable products... Review of fundamental writings.
2. Financial management: functional and differential balance sheets, functional and financial balances; ratio; rentability ground; intermediate management sales; operation funds and needs of operation funds, auto financing ability, financing tables. Civil and banking laws.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Lectures notes, useful articles

COURSE TAUGHT IN French

[ECO1-M3] MACROECONOMICS

INSTRUCTOR Claire Loupias

MISSION AND CONTEXT Compulsory course

OBJECTIVES Introduction to macroeconomics. Be able to understand economic news.

PUBLIC Bachelor level

KEYWORDS *ISLM, money creation, monetary policy, fiscal policy, public debt*

DURATION 15.75 hours

ORGANIZATION Course: 8 sessions – Final Exam: 1 session

CONTENT
The Goods Market – Financial Markets;
Goods and Financial Markets: The IS-LM Model – The Labor Market;
Putting All Markets Together: The AS/AD Model;
The Phillips Curve, the Natural Rate of Unemployment, and Inflation;
The Crisis – The Facts of Growth;
Saving, Capital Accumulation, and Output;
Technological Progress and Growth;
Technological Progress. The Short, the Medium, and the Long Run;
Expectations: The Basic Tools, Consumption, and Investment, Output, and Policy;
Openness in Goods and Financial Markets;
The Goods Market in an Open Economy;
Output, the Interest Rate, and the Exchange Rate.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Course outline, professor's notes, tutorial notes

SUGGESTED READINGS – Blanchard, O., Johnson, D. H., *Macroeconomics*, Prentice Hall, 2013.

COURSE TAUGHT IN French – English

[IBD] DATABASE DESIGN

PROFESSOR Marie Szafranski

MISSION AND CONTEXT Compulsory course

OBJECTIVES This course aims to provide methodological and technical concepts on relational databases. At the end of this course, the students will be able to design a normalized relational database, create a database ensuring the consistency and the integrity of the data and take advantage of its information.

PUBLIC Bachelor level

DURATION 42 hours

ORGANIZATION Course: 8 sessions – Tutorial Classes: 6 sessions – Practical Work: 8 sessions – Final Exam: 1 session

CONTENT General concepts – Conceptual and relational modeling – Database normalization – SQL: basics and advanced – Transactions.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, training and practice exercices

SUGGESTED READINGS
– Date, C. J., *An Introduction to Database Systems*, 8th edition, 2009 ;
– Gardarin G., Bases de données : objet et relationnel, 5e édition, 2003.

COURSE TAUGHT IN French

[IPI] IMPERATIVE PROGRAMMING

PROFESSOR Guillaume Burel

MISSION AND CONTEXT Compulsory course

OBJECTIVES The lecture emphasises the notion of mutable data structure, its goal is to give student the ability to chose or to design a data structure that is well-suited to the problem they have to solve, and then to use the programming language that is the most relevant with reference to the struture and its wanted properties. That is, as an engineer should proceed. This lecture on imperative style programming introduces structures that are « mutable » and side effects. It is scheduled before the lecture on functional programming, organized around the notion of persistency; both paradigms being used in the Advanced Programming lecture.

PUBLIC Bachelor level

DURATION 42 hours

ORGANIZATION Course: 8 sessions – Tutorial Classes: 4 sessions – Practical Work: 12 sessions

CONTENT Memory model; a little syntax; statically allocated structures:arrays, algorithms on arrays; dynamically allocated structures (alloc/free).

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Partial course notes

SUGGESTED READINGS – Froidevaux, C., Gaudel, M.-C., Soria, M., *Types de données et algorithmes*, Ediscience, 1993.

COURSE TAUGHT IN French – English

[OSS] COMPUTER SYSTEM

PROFESSOR	Gérard Berthelot
MISSION AND CONTEXT	Compulsory course
OBJECTIVES	To provide students with basic knowledge of software low layers.
PUBLIC	Bachelor level
DURATION	42 hours
DIVISION	OSS-M1 – Command Execution and Process Management OSS-M2 – Kernel Services of Linux Operating System
ECTS	4
COURSE TAUGHT IN	French

[OSS-M1] COMMAND EXECUTION AND PROCESS MANAGEMENT

INSTRUCTOR	**Gérard Berthelot**
MISSION AND CONTEXT	Compulsory course
OBJECTIVES	Mastering the command language and script shells. Understanding the mechanisms used to execute commands, programs, and manage computer resources for processes.
PUBLIC	Bachelor level
DURATION	17.5 hours
ORGANIZATION	Lectures: 2 sessions – Pratical work on computer: 7 sessions – Examination: pratical work in limited time, 1 session
CONTENT	Commands: syntax, parameters, input, outputs, redirections, pipe-lining. Scripts, parameters, variables, tests, loops, cases, function. Time slicing and Scheduler, vitual memory.
EVALUATION (SESSION 1)	Practical work on computer in limited time, without document
EVALUATION (SESSION 2)	Examination without documents
COURSE TAUGHT IN	French

[OSS-M2] KERNEL SERVICES OF LINUX OPERATING SYSTEM

INSTRUCTOR	**Gérard Berthelot**
MISSION AND CONTEXT	Compulsory course
OBJECTIVES	To master system calls to use files, create and manage processes and threads.
PUBLIC	Bachelor level
DURATION	24.5 hours
ORGANIZATION	Course: 2 sessions – Pratical work on computer: 11 sessions – Examination: pratical work in limited time, 1 session
CONTENT	Study and practice of kernel calls: open, read, write, dup, close, pipe, fork, wait, pause, sleep, kill, exit
EVALUATION (SESSION 1)	Practical work on computer in limited time, without document
EVALUATION (SESSION 2)	Examination without documents
COURSE TAUGHT IN	French

[MAN] NUMERICAL ANALYSIS

PROFESSOR Vincent Torri

MISSION AND CONTEXT Compulsory course

OBJECTIVES The training course introduces the students to the numerical analysis from two angles: numerical matrix analysis and numerical ordinary differential equations analysis. This course is a requirement for some optional courses in the second year, especially with the numerical analysis of partial differential equations. The numerical analysis of ordinary differential equations is a first approach of the discretization of a differential equations (simple case of partial differential equations) and provides the tools to solve them. The numerical matrix analysis shows different methods to solve linear systems. They are used in the algorithms which compute approximations of partial differential equations.Theoretical and algorithmic aspects are put forward in this course: theorem and their proofs as well as algorithms written in pseudocode.

PUBLIC Bachelor level

DURATION 42 hours

ORGANIZATION Main course: 8 sessions – Tutorial classes: 10 sessions – Practical Work: 5 sessions

CONTENT This part is divided into two parts. The first part deals with the numerical solutions of a linear system, using two different methods: Direct methods and Iterative methods. The algorithmic side as well as the numerical complexity of each method is put forward. The second part deals with the numerical solutions of differential equations. The Euler method is presented first, followed by a generalization (one step method).

EVALUATION (SESSION 1) Intermediate examination (IE) and final examination (FE)

EVALUATION (SESSION 2) Oral Exam or Written Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS
– Ciarlet, P. G., *Introduction à l'analyse numérique matricielle et à l'optimisation*, Dunod, 2007;
– Lascaux, P., Theodor, R., *Analyse numérique matricielle appliquée à l'art de l'ingénieur*, Dunod, 2004;
– Demailly, J.-P., *Analyse numérique et équations différentielles*, EDP Sciences, 2006.

COURSE TAUGHT IN French

[MCI] MEASURE THEORY AND INTEGRATION

PROFESSOR Dasha Loukianova

MISSION AND CONTEXT Compulsory course – Class designed for the L3 Mathematics pathway

OBJECTIVES To prepare the theoretical Background necessary in subjects such as "Stochastic processes". This course covers an introduction to abstract measure theory and the Lebesgue integral. We will begin by defining the Lebesgue integral, prove the main convergence theorems, and construct Lebesgue measure in Rn. Other topics include Lp-spaces, Radon-Nikodym Theorem, Lebesgue Differentiation Theorem, Fubini Theorem.

PUBLIC Bachelor level

KEYWORDS *Sigma-field, Lebesgue integral, Fubini theorem*

DURATION 42 hours

ORGANIZATION Course: 16 sessions – Tutorial Classes: 12 sessions

CONTENT Measure Spaces and Sigma-algebras;
Operations on Measurable Functions (Sums, Products, Composition);
Real-valued Measurable Functions;
Limits of Measurable Functions;
Comparison of Lebesgue and Riemann Integrals;
Properties of Positive Measures;
Elementary Properties of the Lebesgue Integral

EVALUATION (SESSION 1) Midterm Exam, Final Exam

ECTS 4

DOCUMENTATION PROVIDED Course outline, professor's notes, tutorial notes

SUGGESTED READINGS
– Rudin, W., *Real and complex analysis*, McCraw-Hill international, 1987;
– Briane, M., Pagès, G., *Théorie de l'intégration*, Vuibert, 2012.

COURSE TAUGHT IN French – English

[MOM] MATHEMATICAL TOOLS

PROFESSOR Christophe Mouilleron

MISSION AND CONTEXT Compulsory course

OBJECTIVES The main goal is to give to students with a background in computer science the opportunity to obtain a reliable basis in mathematics. The different lessons introduce the most crucial mathematical concepts for a future engineer. For each concept, the students are given several exercices illustrating some problems and how to tackle them thanks to this concept. At the end of the course, students are expected to be able to recognize classic problems and to solve them using the appropriate method.

PUBLIC Bachelor level

DURATION 42 hours

ORGANIZATION Course: 12 sessions – Tutorial Classes: 12 sessions

CONTENT Functions of a real variable, complex numbers, polynomials, matrices, matrix diagonalization, integral calculus, Taylor series, integrability, numeric sequences and series, power series.

EVALUATION (SESSION 1) Continuous assessment: regular written exams and assignments during the whole semester

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Training Exercises and Corrected Exercises

COURSE TAUGHT IN French

[MPR] PROBABILITY

PROFESSOR Vathana Ly Vath

MISSION AND CONTEXT Compulsory course

OBJECTIVES This course is designed to provide a thorough preparation for further study in statistics and data analysis. This is a graduate-level course covering random variables, Kolmogorov's theorem and large number laws. Other topics include Lindeberg–Levy 's theorem of central limit, conditional expectation, uniform integrability. This unit offers a comprehensive introduction to data analysis, sampling, and inference including t-tests, confidence intervals and chi-squared goodness of fit tests.

PUBLIC Bachelor level

DURATION 42 hours

ORGANIZATION Course: 11 sessions – Tutorial Classes: 12 sessions – Final Exam: 1 session

CONTENT Use basic counting techniques (multiplication rule, combinations, permutations) to compute probability and odds. Compute conditional probabilities directly and using Bayes' theorem, and check for independence of events. Set up and work with discrete random variables. In particular, understand the Bernoulli, binomial, geometric and Poisson distributions. Work with continuous randam variables. In particular, know the properties of uniform, normal and exponential distributions. Understand the law of large numbers and the central limit theorem. Compute the covariance and correlation between jointly distributed variables.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Partial course notes, academic papers – Training exercises and corrected exercises

SUGGESTED READINGS
– Billingsley, P., *Probability and Measure*, Anniv. ed. Wiley, 2012;
– Dudley, R. M., *Real Analysis and Probability*, Cambridge University Press, 2002;
– Stroock, D., *Probability Theory: An Analytic View*, Cambridge University Press, 2010.

COURSE TAUGHT IN French – English

[MTG] GRAPH THEORY

PROFESSOR Alain Faye

MISSION AND CONTEXT Compulsory course

OBJECTIVES This course is an introduction to Graph Theory. Graphs are used to modelize a lot of combinatorial problems: schedulding, supply chain, transportation problems,... In this course, we introduce the main definitions and properties relative to graphs. The aim is to give tools that will help the engineer to modelize discrete optimization problems.

PUBLIC Bachelor level

DURATION 42 hours

ORGANIZATION Course: 11 sessions – Tutorial Classes: 12 sessions – Final Exam: 1 session

CONTENT Basic definitions – Connexity, strong connexity – Complexity, NP complete problems – Independent set of vertices, vertex coloring, edge coloring – Planar graphs – Trees – Shortest paths – Scheduling problems.

EVALUATION (SESSION 1) Continuous assessment – Written Exam

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS
– Bollobas, B., *Modern Graph Theory*, Graduate Texts in Mathematics 184, Springer, 1998;
– Berge, C., *The Theory of Graphs*, Dover Publications, 2001.

COURSE TAUGHT IN French

SEMESTER 2 S2

COMPULSORY COURSES

[LVFH2] FOREIGN LANGUAGES AND COMMUNICATION

PROFESSOR Laurence Bourard

MISSION AND CONTEXT Compulsory course

OBJECTIVES The Language modules are designed to help students engage in an increasingly globalized economy and to give them the means to expand their horizons. Students are offered an opportunity to further their spoken and written skills both in English and in another foreign language.
The Communication module focuses on basic notions that will teach students to communicate effectively in the workplace. This course aims to increase their confidence by honing their interpersonal communicative skills.

PUBLIC Bachelor level

DURATION 45.5 hours

PREREQUISITES S1-[LVFH1]

DURATION 42 hours

DIVISION LVFH2-M1 – English as a Foreign Language
LVFH2-M2 – Foreign Language
LVFH2-M3 – Soft Skills in the Workplace

ECTS 3

COURSE TAUGHT IN Arabic – Chinese – English – French – German – Italian – Japanese – Portuguese – Russian – Spanish

[LVFH2-M1] ENGLISH

INSTRUCTOR Laurence Bourard

MISSION AND CONTEXT Compulsory course

OBJECTIVES Enabling students to improve their command of English. Helping them reach the B2 level or C1 level of the Common European Framework of Reference for Languages. Preparing them for a test that certifies their proficiency in the English language (TOEIC or BULATS for example).

PUBLIC Bachelor level

DURATION 17.5 hours

ORGANIZATION 10 sessions

CONTENT Classwork revolves around learner-centered activities based on authentic materials drawn from periodicals, audio/video resources and websites. Small-size groups allow students to develop their language abilities: listening, reading, speaking/interacting and writing skills.

EVALUATION (SESSION 1) 20% of the final mark: class attendance (more than 2 unexcused absences will result in a "0" score)
40%: continuous assessment (graded coursework)
40%: final examination

EVALUATION (SESSION 2) Depending on the number of students who are allowed to resit, the make-up exam will be either an oral or a written test

COURSE TAUGHT IN English

[LVFH2-M2] FOREIGN LANGUAGES

INSTRUCTOR Isabelle Malefant, Manuel Caldera Bracho, Alberto Suarez Rojas, Yi Starck, Yukiko Fargues, Janna Hermant, Rita Maubert, Christine Cracosky, Karine Bailly, Mahgol Salémi

MISSION AND CONTEXT Compulsory course

OBJECTIVES This module gives students an opportunity to hone their spoken and written skills in another foreign language. ENSIIE offers a choice of 9 language courses: Arabic, Chinese, French, German, Italian, Japanese, Portuguese, Russian, Spanish.
The FSL course (French as a Second Language) is designed for international students.

PUBLIC Bachelor level

DURATION 17.5 hours

ORGANIZATION 10 sessions

CONTENT Authentic materials are used, from press articles to music, games and literature. Learners are to enhance their knowledge of the language they have chosen to study and also increase their level of cross-cultural awareness and international competence.

EVALUATION (SESSION 1) 20% of the final mark: class attendance (more than 2 unexcused absences will result in a ''0'' score)
40%: continuous assessment (graded coursework)
40%: final examination

EVALUATION (SESSION 2) Written Test

DOCUMENTATION PROVIDED Press articles, music, games

COURSE TAUGHT IN Arabic – Chinese – French – German – Italian – Japanese – Portuguese – Russian – Spanish

[LVFH2-M3] SOFT SKILLS IN THE WORKPLACE

INSTRUCTOR Francine Attia, Laurence Faure, Catherine Lagarde

MISSION AND CONTEXT Compulsory course

OBJECTIVES The aim of this module is to teach communication skills and enable students to improve their interpersonal competence and confidence.

PUBLIC Bachelor level

DURATION 10.5 hours

ORGANIZATION 6 sessions

CONTENT
1. Introducing oneself;
2. Adapting to different situations;
3. Speaking in public, presentation skills;
4. Writing a CV;
5. Writing an effective cover letter;
6. The art of persuasion: convincing and influencing others;
7. Conducting a job interview.

EVALUATION (SESSION 1) 20% of the final mark: class attendance
40%: continuous assessment (graded coursework)
40%: written examination
Two unexcused absences will result in a score of ''0'' for class attendance and students with more than two unexcused absences will receive a 50% deduction in their coursework grade

EVALUATION (SESSION 2) There is no make-up exam session for this module.

COURSE TAUGHT IN French

[ECO2] ECONOMICS MANAGEMENT

PROFESSOR Thomas Lim

MISSION AND CONTEXT Compulsory course

OBJECTIVES The goal of this course unit is to understand the economic change in considering the problem Firms-Nations-Market-Territories.
The economy is now a balance of power between these four actors:
1. The firms are the main actors;
2. The nations defend some long term social and economic balances contrary to the firms which have short term view;
3. The markets are global and connected;
4. The territories in which are the firms and the people.

PUBLIC Bachelor level

DURATION 42 hours

DIVISION ECO2-M1 – Microeconomics
ECO2-M2 – Investment and project management
ECO2-M3 – Introduction to entrepreneurship

ECTS 3

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

COURSE TAUGHT IN French - English

[ECO2-M1] MICROECONOMICS

INSTRUCTOR Nessrine Omrani

MISSION AND CONTEXT Compulsory course

OBJECTIVES To give the basics of economic environment and present the fundamentals of business' commercial trades. Analyse and predict the behavior of agents in a given economic, technical or social environment. Analyse and predict the social interactions between agents as a result of this behavior. Analyse the product of these interactions, whether there are institutions responsible of their organization or as a result of the interplay of less formalized interaction mechanisms, *e.g.* the exchanges.

PUBLIC Bachelor level

DURATION 15.75 hours

ORGANIZATION 9 sessions

CONTENT Introduction: main notions and basic concepts, the economic agents and microeconomic and macroeconomic procedures.
Microeconomics in perfect markets: consumer's theory (consumption, savings, employment offers); producers' theory (production function, returns); the law of supply and demand); optimal and general equilibrium, opportunity cost, sunk cost, marginal cost; funding and risk management.
Microeconomics in imperfect markets: monopolies/ oligopolies, imperfect information, public intervention. Accounting and financial management.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Lecture notes, useful articles

SUGGESTED READINGS – Levitt, S. D., Dubner, S. J., *Freakonomics: A Rogue Economist Explores the Hidden Side of Everything*, Harper Perennial, 2009.

COURSE TAUGHT IN French

[ECO2-M2] INVESTMENT AND PROJECT MANAGEMENT

INSTRUCTOR	**Mouna Prost**
MISSION AND CONTEXT	**Compulsory course**
OBJECTIVES	Introduction to corporate finance.
PUBLIC	**Bachelor level**
DURATION	**15.75 hours**
ORGANIZATION	Course: 8 sessions – Final Exam: 1 session
CONTENT	Accounting with a financial view point. investment analysis tools, enterprise valuation
EVALUATION (SESSION 1)	Written Exam
EVALUATION (SESSION 2)	Written Exam
COURSE TAUGHT IN	**French – English**

[ECO2-M3] INTRODUCTION TO ENTREPRENEURSHIP

INSTRUCTOR Sébastien Cauwet

MISSION AND CONTEXT Compulsory course

OBJECTIVES At the end of the course, students should be able to: 1) See the entrepreneurial phenomenon within the economic sphere; 2) Build up a summarized business plan; 3) Use some tools that helps to achieve a business plan.
It is aimed at sensitizing students to entrepreneurship in its widest meaning (creation, entrepreneurship, intrapreunarship, acquisition, expansion, franchising, etc.). The class doesn't aim at making students become entrepreneur but at showing them there is not only big companies that can make them find their profession very fulfilling, while presenting them the idiosyncresy of intrapreneurship within big groups. However, many of them may become effectively "enterprising".
The course will focus on entrepreneurial projects in areas such as ITC, services, innovation, sustainable development and corporate ethics and humanities.
There will also be a preparation to the effective act of proceeding, that will be followed by "Challenge Projets d'Entreprendre" – a pedagogical test and a common week of work for students from ENSIIE, TELECOM École de Management and TELECOM SudParis in the second year.

PUBLIC Bachelor level

PREREQUISITES S1-[ECO1]

DURATION 10.5 hours

ORGANIZATION Course: 6 sessions

CONTENT Definitions of entrepreneurship – Characteristics of entrepreneurs identified in the literature – Diversity of entrepreneurs, the importance of self-awareness, self-awareness tools and techniques – Different fields of entrepreneurship, such as social, technology, corporate, etc. – Sources of ideas and opportunities, and how an idea becomes an opportunity – Challenges faced by entrepreneurial ventures and techniques for evaluating entrepreneurial opportunities – Generic challenges that apply to different fields of entrepreneurship.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Professor's notes, tutorial notes

COURSE TAUGHT IN French

TEACHING UNIT

[PWR] WEB PROGRAMMING AND SYSTEM CALLS

PROFESSOR Anne-Laure Ligozat

MISSION AND CONTEXT Compulsory course

OBJECTIVES To learn how to design and develop web applications using a data base server with an N-tier architecture. To learn how to design and develop applications using basic kernel services of an operating system: files, communications, processes, threads.

PUBLIC Bachelor level

DURATION 42 hours

DIVISION PWR-M1 – Web Programming and Automatized Information Systems
PWR-M2 – Kernel Services of Linux Operating System

ECTS 4

COURSE TAUGHT IN French

[PWR-M1] WEB PROGRAMMING AND AUTOMATIZED INFORMATION SYSTEMS

INSTRUCTOR Anne-Laure Ligozat

MISSION AND CONTEXT Compulsory course

OBJECTIVES To learn how to design and develop web applications using a data base server with an N-tier architecture. Introduction to optimization problems related to data base accesses. Introduction to the data description model XML (as the most widespread data description model used for data exchanges inside or between Information Systems).

PUBLIC Bachelor level

DURATION 21 hours

ORGANIZATION Lectures: 4 sessions – Practical work on computer: 7 sessions - Final Exam: 1 session

CONTENT N-tier server architecture, light client, design pattern MVC, ergonomic man-machine interface, HTML, java, javascript, web application security, relations storage, indexing, DB query optimization, DB access optimization, XML and DTD data modelling , XSLT.

EVALUATION (SESSION 1) Practical work on a computer in limited time

EVALUATION (SESSION 2) Practical work on a computer in limited time

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

COURSE TAUGHT IN French

[PWR-M2] KERNEL SERVICES OF LINUX OPERATING SYSTEM

INSTRUCTOR	**Gérard Berthelot**
MISSION AND CONTEXT	Compulsory course
OBJECTIVES	To master system calls to use files. Mastering system calls to use and manage processes. Design and development of communication processes using pipes.
PUBLIC	Bachelor level
DURATION	21 hours
ORGANIZATION	Lectures: 4 sessions – Practical work on computer: 7 sessions + 1 evaluation session
CONTENT	Study and practice of kernel calls: open, read, write, dup, close, pipe, fork, wait, pause, sleep, kill, exit.
EVALUATION (SESSION 1)	Practical work on a computer in limited time
EVALUATION (SESSION 2)	Practical work on a computer in limited time
DOCUMENTATION PROVIDED	Lecture slides, partial course notes, academic papers
COURSE TAUGHT IN	French

[ILO] OBJECT ORIENTED LANGUAGES

PROFESSOR	David Roussel
MISSION AND CONTEXT	Compulsory course
OBJECTIVES	Understanding the object concepts and basics of object modeling through Java and C++ languages and UML notation.
PUBLIC	Bachelor level
DURATION	42 hours
ORGANIZATION	Course: 8 sessions – Practical Work: 15 sessions – Final Exam: 1 session
CONTENT	Object concepts and langages (Java & C++) – UML basics – Illustrated with the Gang of Four Design Patterns.
EVALUATION (SESSION 1)	Written Exam
EVALUATION (SESSION 2)	Written Exam
ECTS	4
COURSE TAUGHT IN	French – English

[IPFL] FUNCTIONAL PROGRAMMING AND LOGIC

PROFESSOR Julien Forest

MISSION AND CONTEXT Compulsory course

OBJECTIVES The teaching unit gives complements in programming by introducing the fundamentals of logic for analyzing and correcting programs, in particular for critical systems. The objective is to make students produce nontrivial programs by selecting relevant data structures and proving correctness. After completing this course students should be able to read and write code for imperative algorithms and data structures.

PUBLIC Bachelor level

DURATION 42 hours

DIVISION IPFL-M1 – Introduction to Functional Programming
IPFL-M2 – Logic

ECTS 4

SUGGESTED READINGS
– Abelson, H., Sussman, G.J., *Structure and Interpretation of Computer Programs*, MIT Press, 1996;
– Felleisen, M., Findler, R. B., Flatt, M., Krishnamurthi, S., *How to Design Programs*, MIT Press, 2003;
– Krishnamurthi, S. *Programming Languages: Application and Interpretation*, Version 2007-04-26.

COURSE TAUGHT IN French - English

[IPFL-M1] INTRODUCTION TO FUNCTIONAL PROGRAMMING

INSTRUCTOR Catherine Dubois

MISSION AND CONTEXT Compulsory course

OBJECTIVES This course is an introduction to the Functional Programming paradigm; it is developed around the notion of persistant data structure and eteratores. During praticals, some emphasis will be put on roof of programs and dependability.

PUBLIC Bachelor level

DURATION 21 hours

ORGANIZATION Course: 4 sessions – Tutorial classes: 3 sessions – Practical work: 4 sessions – Final Exam : 1 session

CONTENT Functional keurel and exceptions, same types, inductive types, sets (lists, trees...) – Course is based on Ocaml.

EVALUATION (SESSION 1) Project + Final Exam

EVALUATION (SESSION 2) Final Exam

DOCUMENTATION PROVIDED Lecture slides and occasional references from the slides will form good reading materials for this course

SUGGESTED READINGS – Odersky, M., Spoon, L., Venners, B., *Programming in Scala*, Artima, 2011.

COURSE TAUGHT IN French - English

[IPFL-M2] LOGIC

INSTRUCTOR	Julen Forest
MISSION AND CONTEXT	Compulsory course
OBJECTIVES	In this course we will cover central aspects of modern formal logic, beginning with an explanation of what constitutes good reasoning. Topics will include validity and soundness of arguments, formal derivations, truth-functions, translations to and from a formal language, and truth-tables.
PUBLIC	Bachelor level
DURATION	21 hours
ORGANIZATION	Course: 5 sessions – Tutorial classes: 6 sessions – Final Exam: 1 session
CONTENT	Introduction to formal logic: Basic notions of logic; arguments; the connectives – Induction, notion of order, recurrence and proofs – Boole algebra, propositional logic – First order logic and Curry-Howard isomorphism.
EVALUATION (SESSION 1)	Pratical + Final Exam
EVALUATION (SESSION 2)	Final Exam
DOCUMENTATION PROVIDED	Lecture slides and occasional references
SUGGESTED READINGS	– Barker-Plummer, D., Barwise, J., Etchemendy, J. *Language, Proof, and Logic*, Center for the Study of Language and Information, 2011; – Gensler, H. J., *Introduction to Logic*, Routledge, 2010.
COURSE TAUGHT IN	French - English

[OPTI] OPTIMIZATION

PROFESSOR Alain Faye

MISSION AND CONTEXT Compulsory course

OBJECTIVES Operation research analysts, engineers, managers, and planners are confronted by optimization problems that need solving. The problems may involve arriving at an optimal design, allocating scarce resources, planning industrial operations, scheduling aircraft at an airport and so on. During the last decades, there has been a very rapid growth of optimization models and techniques. The growth of large and fast computing facilities has aided in the use of the techniques developed. There exist, now, a lot of solvers. Engineers must have the knowledge for using these facilities efficiently in order to solve their problems. The goal of this course is to bring them this knowledge.

PUBLIC Bachelor level

DURATION 42 hours

ORGANIZATION Course: 12 sessions – Tutorial Classes: 11 sessions – Final Exam: 1 session

CONTENT Unconstrained optimization via calculus – Convex functions – Iterative methods for unconstrained optimization – Constraint qualification and Karush-Kuhn-Tucker optimality conditions – Lagrangian duality – Primal iterative methods – Penalty and barrier methods.

EVALUATION (SESSION 1) Continuous Assessment (50%) – Final Written Exam (50%)

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Partial course notes

SUGGESTED READINGS
– Luenberger, D. G, *Linear and non linear programming*, Springer, 2003;
– Peressini, A.L., Sullivan,F. E., Uhl, J. J. Jr, *The Mathematics of Nonlinear Programming*, Springer, 1993;
– Bazaraa, M. S., Sherali, H.D., Shetty, C. M., *Nonlinear Programming Theory and Algorithms*, Wiley-Intersciences, 2006;
– Culioli, J.-C., *Introduction à l'optimisation*, Ellipses, 1994.

COURSE TAUGHT IN French

TEACHING UNIT

[PROJ] IT AND MATHEMATICS PROJECTS

PROFESSOR Guillaume Burel – Thomas Lim

MISSION AND CONTEXT Compulsory course

OBJECTIVES The project aims at making students work together in a team on a project which contains an important part of programming and which requires a good coordination between the members of the student groups. Projects are supervised in class with teachers guiding the members of each group and rating their work.

PUBLIC Bachelor level

DURATION 42 hours

DIVISION
PROJ-M1 – IT project
PROJ-M2 – Web project
PROJ-M3 – Maths project

ECTS 4

COURSE TAUGHT IN French

[PROJ-M1] IT PROJECT

INSTRUCTOR Guillaume Burel

MISSION AND CONTEXT Compulsory course

OBJECTIVES The project aims to have students work in teams on a project that includes an important part of programming and that requires good coordination between students of the same group. Project monitoring is done during working sessions to guide and evaluate the work of members of each group.

PUBLIC Bachelor level

DURATION 21 hours

ORGANIZATION 12 sessions

EVALUATION (SESSION 1) Project with presentation

EVALUATION (SESSION 2) None

COURSE TAUGHT IN English in demand, French by default

[PROJ-M2] WEB PROJECT

INSTRUCTOR	**Guillaume Burel**
MISSION AND CONTEXT	**Compulsory course**
OBJECTIVES	Development of a small thin-client program (php – html – javascript – postgreSQL).
PUBLIC	**Bachelor level**
DURATION	**10.5 hours**
ORGANIZATION	6 sessions
EVALUATION (SESSION 1)	Project with presentation
EVALUATION (SESSION 2)	None
COURSE TAUGHT IN	**French**

[PROJ-M3] MATHEMATICS

INSTRUCTOR Thomas Lim

MISSION AND CONTEXT Compulsory course

OBJECTIVES The project aims at making students work together on a mathematical project. The students must understand a mathematical problem, then how to model it, and finally how to solve it.

PUBLIC Bachelor level

PREREQUISITES S1-[MPR]

KEYWORDS *Simulation, modelling*

DURATION 10.5 hours

ORGANIZATION Practical work

CONTENT Some example of subjects: pricing and hedging of a European option with the binomial tree model, the Cox-Ross-Rubinstein model and the Black-Scholes model ; computation of an integral by discretization.

EVALUATION (SESSION 1) Project with presentation

EVALUATION (SESSION 2) None

DOCUMENTATION PROVIDED Professor's notes, tutorial notes

SUGGESTED READINGS – Grenier, J.-P., *Débuter en Algorithmique avec Matlab et Scilab*, Ellipses Marketing, 2007.

COURSE TAUGHT IN French

[MST] STATISTICS

PROFESSOR Nicolas Brunel

MISSION AND CONTEXT Compulsory course

OBJECTIVES Introduction to the mathematical theory of statistics: To provide necessary statistical background for analyzing data and drawing inferences from that analysis. To increase the student's mastery of the deductive nature of reasoning. Estimation, with a focus on properties of sufficient statistics and maximum likelihood estimators. Hypothesis testing, with a focus on likelihood ratio tests and the consequent development of "t" tests and hypothesis tests in regression and ANOVA. Nonparametric procedures.

PUBLIC Bachelor level

PREREQUISITES S1-[MTR]

DURATION 42 hours

ORGANIZATION Course: 8 sessions – Tutorial Classes: 10 sessions – Practical Work: 5 sessions – Final Exam: 1 session

CONTENT Create and interpret scatter plots and histograms. Understand the difference between probability and likelihood functions, and find the maximum likelihood estimate for a model parameter. Construct estimates and predictions using the posterior distribution. Find credible intervals for parameter estimates. Use null hypothesis significance testing (NHST) to test the significance of results, and understand and compute the p-value for these tests. Use specicific significance tests including, z-test t-test (one and two sample), chi-squared test. Find confidence intervals for parameter estimates.

EVALUATION (SESSION 1) Continuous Assessment (25%) + Project (25%) + Final Exam (50%)

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS – Wasserman, L., *All of statistics: a concise course in statistical inference*, Springer, 2004.

COURSE TAUGHT IN French – English

Heqing Huang, China

I am a international student in ENSIIE. One year ago, with the passion to the computer science and bits of fear and nervous, I started to get used to the new life. As the time flow, i found out there are many things so appreciable that make me feel more and more belongingness to here, which like the patient teachers, friendly students, various of the club activities, and perfect quality of the education. ENSIIE always regards students as the first place, all the people here make me feel that you were not really in the foreign land, you can also be treated as a important member in the group, which left all the international students no difficulties to adapt to the life here. In the same time, not only we can learn many things in the class, but ENSIIE also provides many chance for the real skill that will be used in the company can be practiced. In addition, I make lots of friends here!

Now, I am about to be a second year student, what impress me are that there are many choices can be made for the courses depend on what you really want to do. By the way, the international exchange program in our school is also very good which you can go to many famous schools and universities for a nice new experience of study. For all the students wishing to come and study at ENSIIE for one term or more, I guarantee a very rich multicultural experience.

I LOVE ENSIIE!

SEMESTER 3 S3

COMPULSORY COURSES

ELECTIVE COURSES

TEACHING UNIT

[LVFH3] FOREIGN LANGUAGES AND COMMUNICATION

PROFESSOR Laurence Bourard

MISSION AND CONTEXT Compulsory course

OBJECTIVES The Language modules are designed to help students engage in an increasingly globalized economy and to give them the means to expand their horizons. Students are offered an opportunity to further their spoken and written skills both in English and in another foreign language. The second-year Communication modules focus on business communication strategies.

PUBLIC Master level

PREREQUISITES S1-[LVFH1], S2-[LVFH2]

DURATION 42 hours

DIVISION LVFH3-M1 – English as a Foreign Language
LVFH3-M2 – Foreign Language
LVFH3-M3 – Communication Strategies for Businesses

ECTS 3

COURSE TAUGHT IN Arabic – Chinese – English – French – German – Italian – Japanese – Portuguese – Russian – Spanish

[LVFH3-M1] ENGLISH AS A FOREIGN LANGUAGE

INSTRUCTOR Laurence Bourard

MISSION AND CONTEXT Compulsory course

OBJECTIVES Enabling students to improve their command of English. Helping them reach the B2 level or C1 level of the Common European Framework of Reference for Languages. Preparing them for a test that certifies their proficiency in the English language (TOEIC or BULATS for example).

PUBLIC Master level

DURATION 17.5 hours

ORGANIZATION Number of periods: 10

CONTENT Classwork revolves around learner-centered activities based on authentic materials drawn from periodicals, audio/video resources and websites. Small-size groups allow students to develop their language abilities: listening, reading, speaking/interacting and writing skills. Learners are also given access to a language lab and a platform on which they complete different assignments, including practice tests (mostly TOEIC and TOEFL).

EVALUATION (SESSION 1) 20% of the final mark: class attendance (more than 2 unexcused absences will result in a ¨0¨ score)
40%: continuous assessment (graded coursework)
40%: final examination

EVALUATION (SESSION 2) Depending on the number of students who are allowed to resit, the make-up exam will be either an oral or a written test

COURSE TAUGHT IN English

[LVFH3-M2] FOREIGN LANGUAGES

INSTRUCTOR Isabelle Malefant, Manuel Caldera Bracho, Alberto Suarez Rojas, Yi Starck, Yukiko Fargues, Janna Hermant, Rita Maubert, Christine Cracosky, Karine Bailly, Mahgol Salémi

MISSION AND CONTEXT Compulsory course

OBJECTIVES This module gives students an opportunity to hone their spoken and written skills in another foreign language. ENSIIE offers a choice of 9 language courses: Arabic – Chinese – French – German – Italian – Japanese – Portuguese – Russian – Spanish. The FSL course (French as a Second Language) is designed for international students.

PUBLIC Master level

DURATION 17.5 hours

ORGANIZATION Number of periods: 10

CONTENT Authentic materials are used, from press articles to music, games and literature. Learners are to enhance their knowledge of the language they have chosen to study and also increase their level of cross-cultural awareness and international competence.

EVALUATION (SESSION 1) 20% of the final mark: class attendance (more than 2 unexcused absences will result in a ''0'' score)
40%: continuous assessment (graded coursework)
40%: final examination

EVALUATION (SESSION 2) Written test

COURSE TAUGHT IN Arabic – Chinese – French – German – Italian – Japanese – Portuguese – Russian – Spanish

[LVFH3-M3] COMMUNICATION STRATEGIES FOR BUSINESS

INSTRUCTOR Béatrice Juste, Laurent Prével

MISSION AND CONTEXT Compulsory course

OBJECTIVES Analyzing business strategies of external and internal communication, identifying the communication tools used by corporations, examining the difficulties and challenges with which they are confronted.

PUBLIC Master level

DURATION 10.5 hours

ORGANIZATION Number of periods: 6

CONTENT
1. Corporate culture;
2. Corporate image (logo, graphic identity, sound trademark...);
3. Corporate communication (business brochures, Public Relations, sponsoring...);
4. Business communication (professional events, advertising, direct marketing...);
5. Online strategies (e-commerce, websites, social networks...).

EVALUATION (SESSION 1) 20% of the final mark: class attendance
40%: continuous assessment (graded coursework)
40%: written examination
Two unexcused absences will result in a score of ''0'' for class attendance and students with more than two unexcused absences will receive a 50% deduction in their coursework grade.

EVALUATION (SESSION 2) There is no make-up exam session for this module

COURSE TAUGHT IN French

[ECO3] ECONOMICS MANAGEMENT

PROFESSOR Thomas Lim

MISSION AND CONTEXT Compulsory course

OBJECTIVES The goal of this course unit is to understand the economic change in considering the problem Firms-Nations-Market-Territories.
The economy is now a balance of power between these four actors:
1. The firms are the main actors;
2. The nations defend some long term social and economic balances contrary to the firms which have short term view;
3. The markets are global and connected;
4. The territories in which are the firms and the people.

PUBLIC Master level

DURATION 66.5 hours

DIVISION
ECO3-M1 – Introduction to Financial Market
ECO3-M2 – Macroeconomic modelling
ECO3-M3 – Conferences
ECO3-M4 – Civil Law and Computer Science
The students choose Module 1
or Module 2 and must follow Modules 3 and 4

ECTS 3

COURSE TAUGHT IN French – English

[ECO3-M1] INTRODUCTION TO FINANCIAL MARKET

INSTRUCTOR Philippe Castelnau

MISSION AND CONTEXT Compulsory course

OBJECTIVES The goal of this course is that the students understand the classical tools in a financial market.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 11 sessions – Exam: 1 session

CONTENT Organized market-OTC market, bonds, arbitrage, call, put, forward.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

COURSE TAUGHT IN French – English

[ECO3-M2] MACROECONOMIC MODELING

INSTRUCTOR	**Nessrine Omrani**
MISSION AND CONTEXT	Compulsory course
OBJECTIVES	Develop Economic models of grouth, technical progress and innovation.
PUBLIC	Master level
DURATION	21 hours
ORGANIZATION	Course: 11 sessions – Exam: 1 session
CONTENT	Equilibrium :Keynesion, classic and neoclassic theory. Dynamits of equilibrium, technical progress and economic evolution.
EVALUATION (SESSION 1)	Continuous assessment of knowledge by the instructor throughout the course and Written Exam
EVALUATION (SESSION 2)	Written Exam
COURSE TAUGHT IN	French – English

[ECO3-M3] CONFERENCES

INSTRUCTOR	**Thomas Lim**
MISSION AND CONTEXT	**Compulsory course**
OBJECTIVES	Cloud computing explained by professionals.
PUBLIC	**Master level**
DURATION	**7 hours**
ORGANIZATION	Course: 4 sessions
CONTENT	Presentation and description of issues, evolution of cloud computing. Economic model of the cloud.
EVALUATION (SESSION 1)	Presence
EVALUATION (SESSION 2)	None
COURSE TAUGHT IN	**French – English**

[ECO3-M4] CIVIL LAW AND COMPUTER SCIENCE

INSTRUCTOR	Dina de La Croix
MISSION AND CONTEXT	Compulsory course
OBJECTIVES	Help the students to find the different laws about the computer science.
PUBLIC	Master level
DURATION	17.5 hours
ORGANIZATION	Course: 9 sessions – Exam: 1 session
CONTENT	French judicial system. Legal proceedings. Copyright and the digital world. Securing data. National regulatory authorities.
EVALUATION (SESSION 1)	Continuous assessment of knowledge by the instructor throughout the course
EVALUATION (SESSION 2)	None
COURSE TAUGHT IN	French – English

[IPF] FUNCTIONAL PROGRAMMING

PROFESSOR Julien Forest

MISSION AND CONTEXT Elective course

OBJECTIVES The lecture emphasises the notion of persistent data structure, its goal is to give students the ability to choose or to design a data structure that is well-suited to the problem they have to solve, and then to use the programming language that is the most relevant with reference to the struture and its wanted properties. That is, as an engineer should proceed. In this particular lecture, we will get rid of preconceived ideas regarding functional programming, and we will bring to the fore higher order constructs and "persistency" for a few classical data structures.

PUBLIC Bachelor level

DURATION 42 hours

ORGANIZATION Functional kernel, exceptions, inductive types. Sets implemented as: Lists, Binary Research Trees, AVL trees, Zippers,Suffix Trees. Maps... Functions on these structures.

CONTENT Course: 9 sessions – Tutorial Classes: 3 sessions – Practical Work: 11 sessions – Final Exam: 1 session

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

ECTS 4

SUGGESTED READINGS
– Chailloux, E., Manoury, P., Pagano, B., *Développement d'applications avec Objective Caml*, O'Reilly, 2000;
– Cousineau, G., Mauny, M., *Approche fonctionnelle de la programmation*, Édiscience/Dunod, 1995.

COURSE TAUGHT IN French – English

TEACHING UNIT

[LFCVVL] FORMAL LANGUAGES AND COMPILATION

PROFESSOR Catherine Dubois

MISSION AND CONTEXT Elective course

OBJECTIVES These lectures present the main theoretical and practical concepts used in a compiler. Through the study of formal languages, languages classes that can be parsed by a machine. This leads to techniques that can be used for compilers to automatically produce programs that parse the source language. The aims for the students are to know when a language can be easily parsed, how to use existing tools to perform the parsing, and what are the great steps that transform this language into a compiler until the target code is produced.

PUBLIC Master level

DURATION 42 hours

DIVISION LFCVVL-M1 – Formal Languages and Systems
LFCVVL-M2 – Compilation

ECTS 4

COURSE TAUGHT IN French – English

[LFCVVL-M1] FORMAL LANGUAGES AND SYSTEMS

INSTRUCTOR Guillaume Burel

MISSION AND CONTEXT Elective course

OBJECTIVES To understand the issue of describing languages through enumerative processes (grammars), algebraic processes (rational systems) and recognition processes (finite automata). To see that there exists languages that cannot be recognized, depending on the process. To know how to rebuild Lex: techniques based on automata are indeed ubiquitous in computer science; to understand Yacc; to know how to build abstract syntax trees.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 6 sessions – Exam: 1 session – Tutorial
Classes: 3 sessions – Practical Work : 2 sessions

CONTENT Context-free grammars, regular grammars and reductions, rational languages, finite state automata (deterministic, non-deterministic, minimal, pumping lemma). Lexical analysis, syntactic analysis (top-down, bottom-up). Abstract syntax trees.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

COURSE TAUGHT IN French – English

[LFCVVL-M2] SOFTWARE VERIFICATION AND VALIDATION

PROFESSOR Catherine Dubois

MISSION AND CONTEXT Elective course

OBJECTIVES Students will learn fundamentals related to program testing and proving techniques that allow for systematic software validation and verification. This course also introduces the students to some testing and proving tools.

PUBLIC Master level

KEYWORDS *Testing, Structural testing, functional testing, design by contract, proving, Hoare logics, proof obligations*

DURATION 42 hours

ORGANIZATION Course: 8 sessions – Tutorial Classes: 6 sessions – Practical Work: 9 sessions – Exam: 1 session

CONTENT Verification and validation (V&V) in the life cycle, objectives, overview of different techniques.
Functional testing (aka black-box testing).
Structural testing (aka white-box testing).
Design by contract.
Proof of programs, Hoare logics, weakest pre-conditions.
Experimentation with the testing tools Junit, PathCrawler and the plateform FramaC (in particular the plugin WP).

EVALUATION (SESSION 1) Exam and lab sessions assessment

EVALUATION (SESSION 2) Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS – Oberkampf, W. L., Christopher, J. R., *Verification and Validation in Scientific Computing*, Cambridge University Press, 2010.

COURSE TAUGHT IN French – English

[PAP] SCIENTIFIC PROJECT IN OBJECT ORIENTED PROGRAMMING

PROFESSOR	Vincent Torri
MISSION AND CONTEXT	Elective course
OBJECTIVES	To learn how to build and evolve large-scale programs using object-oriented programming. The project focuses on exploration of object-oriented programming C++.
PUBLIC	Master level
PREREQUISITES	S2-[PIAL]
DURATION	42 hours
ORGANIZATION	Course: 14 sessions - Practical work: 9 sessions - Final Exam: 1 session
CONTENT	- Types, control structures, function (default and overloading); - Namespace; - Exceptions; - Classes; - Inheritance.
EVALUATION (SESSION 1)	Continuous assessment + Final Exam
EVALUATION (SESSION 2)	Final Exam
ECTS	4
DOCUMENTATION PROVIDED	Class is organized as part lecture and part guided discussion
SUGGESTED READINGS	– Stroustrup, B., *The C++ Programming Language*, Addison-Wesley, 2013.
COURSE TAUGHT IN	French – English

TEACHING UNIT

[SRM] NETWORK SECURITY AND MIDDLEWARE

PROFESSOR Ivan Augé

MISSION AND CONTEXT Elective course

OBJECTIVES To provide students with mathematic for cryptology, error detection and error correction, with security protocols, with Internet standard protocols, with middleware concept, with distributed application. To learn to develop distributed applications with different middleware tools.

PUBLIC Master level

DURATION 42 hours

ORGANIZATION Course: 8 sessions – Tutorial Classes: 8 sessions – Pratical Work: 6 sessions

CONTENT Internet protocols, Mathematics for cryptology and error control, RSA, error correction, Security protocols, Middleware, PDU generator, RPC, Object middleware.

EVALUATION (SESSION 1) Exam (FE) / Project Report (PR)

EVALUATION (SESSION 2) Exam

ECTS 4

COURSE TAUGHT IN French

[MRO] OPERATIONS RESEARCH

PROFESSOR Dimitri Watel

MISSION AND CONTEXT Elective course

OBJECTIVES Operations Research (OR) is one of the main areas of application of computers in the industry. It includes a set of methods, conceptual models and tools to streamline and optimize the architecture and operation of complex systems (production, network, transport, etc.), technical or techno-economic choice regarding products and generally, the process of decision making in the company. OR is a crossroads discipline involving mathematics, economics and computer science. It is by nature in direct contact with the industry and plays a key role in maintaining competitiveness. The contributions of OR are visible all around us and in the most diverse areas (organization of production lines, rotating crews, portfolio optimization, school bus, etc.). OR is a very broad discipline that has two main areas: combinatorial problems and random problems. The goal of the course is to introduce students to these issues so that they are able to recognize a problem of OR and have some ideas on how to tackle it. For this, the course will address the major problems of conventional OR accurately but not in depth. Note that the basic problems concerning the optimal paths in a graph and schedules are addressed in the first year in the course graph theory and optimization in graphs. Particular emphasis will be placed on one of the most important discipline areas: linear programming.

PUBLIC Master level

DURATION 42 hours

ORGANIZATION Course: 11 sessions – Tutorial Classes: 12 sessions – Exam: 1 session

CONTENT The course is divided into two main parts:
1. Optimization: (a) deterministic dynamic programming, (b) Matrix method for problems of optimal paths in graphs, (c) Scheduling under constraint of resources and scheduling of workshops, (d) Flow Problems: maximum flow and minimum cut, (e) Branch & Bound, application to the traveling salesman problem, (f) Linear programming, the simplex algorithm;
2. Random processes: (a) Markov Processes, (b) The process of birth and death, (c) Markov chain, (d) Waiting Phenomena, (e) Reliability, wear and replacement of equipment, (f) stock-management with uncertain data.

EVALUATION (SESSION 1) Participation grade (5 points) – Written Exam (15 points) –
Students are permitted to access study materials

EVALUATION (SESSION 2) Written Exam

ECTS 4

SUGGESTED READINGS
– Billionnet, A., *Optimisation Discrète*, Dunod, 2007;
– Hêche, J.-F., Liebling, T. M., De Werra, D., *Recherche Opérationnelle pour ingénieurs*, PPUR, 2003;
– Hillier, F., *Introduction to Operations Research*, McGraw Hill, 2015.

COURSE TAUGHT IN French

TEACHING UNIT

[PST] STOCHASTIC PROCESSES

PROFESSOR Abass Sagna

MISSION AND CONTEXT Elective course

OBJECTIVES Give to students some fundamental tools to follow high education in applied mathematics.The objective of this Unit is to study the discrete time stochastic processes, in particular Martingales and Markov chains. We shall give the theoretical foundations and the tools of analysis of the stochastic processes. These stochastic processes intervene in many domains of applied mathematics, in particular, in financial mathematics, in statistics, etc.

PUBLIC Master level

PREREQUISITES S1-[MPR], S2-[MST]

KEYWORDS *Probability, conditional expectation, filtration, Martingales, Markov chains*

DURATION 42 hours

DIVISION PST-M1 – Martingales
PST-M2 – Markov Chains

CONTENT Martingales: overview of probability theory, expectation and conditional expectation, filtration, definition of a (sub/super)-martingale, stopped martingales, convergence theorems, applications. Markov chains: transition matrix, definition of a Markov chain, potential operator, first passage problems, recurrence-transience, invariant measure, applications.

ECTS 4

DOCUMENTATION PROVIDED Lecture notes

SUGGESTED READINGS

– Baldi, P., Mazliak, L., Priouret, P., *Martingales and Markov chains: solved exercises and elements of theory*, Chapman and Hall/CRC, 2002;
– Jacod, J., Protter, P., *Probability essentials*, Springer, 2004;
– Modica, G., Poggiolini, L., *A first course in Probability and Markov chains*, Wiley, 2013;
– Privault, N., *Understanding Markov chains: examples and applications*, Springer, 2013;
– Shiryaev, A. N. , *Probability*, Springer, 1995;
– Williams, D., *Probability with Martingales*, Cambridge Mathematical Textbooks, 1991.

COURSE TAUGHT IN French – English

[PST-M1] MARTINGALES

INSTRUCTOR Abass Sagna

MISSION AND CONTEXT Elective course

OBJECTIVES Give students some fundamental tools to follow high education in Applied Mathematics, more specifically, in Financial Mathematics. This course introduces discrete time Martingales. It gives the theoretical bases and the necessary tools for the analysis of the Martingales properties through diverse practical examples. We will also make simulations to bring to light some theoretical results.

PUBLIC Master level

PREREQUISITES S1-[MPR]

KEYWORDS *Probability, conditional expectation, filtration, Martingales*

DURATION 21 hours

ORGANIZATION Main course: 7 sessions – Tutorial Classes: 3 sessions – Practical Work: 2 sessions

CONTENT Overview of probability theory, expectation and conditional expectation, filtration, definition of a (sub/super)-martingale, stopped martingales, convergence theorems, applications.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Lecture notes

SUGGESTED READINGS
– Baldi, P., Mazliak, L., Priouret, P., *Martingales and Markov chains: solved exercises and elements of theory*, Chapman and Hall/CRC, 2002;
– Jacod, J., Protter, P., *Probability essentials*, Springer, 2004;
– Shiryaev, A. N., *Probability*, Springer, 1995;
– Williams, D., *Probability with Martingales*, Cambridge Mathematical Textbooks, 1991.

COURSE TAUGHT IN French – English

[PST-M2] MARKOV CHAINS

INSTRUCTOR Abass Sagna

MISSION AND CONTEXT Elective course

OBJECTIVES Give students some fundamental tools to follow high education in Statistics. In this course we introduce the Markov chains with countable state spaces. We study the fundamental results on Markov chains and give several practical examples to illustrate their applications. We will also make simulations to bring to light some theoretical results on Markov chains.

PUBLIC Master level

PREREQUISITES S1-[MPR]

KEYWORDS *Probability, conditional expectation, filtration, Markov chains*

DURATION 21 hours

ORGANIZATION Course : 7 sessions – Tutorial Classes: 3 sessions – Practical Work: 2 sessions

CONTENT Overview of probability theory, expectation and conditional expectation, filtration, transition matrix, definition of a Markov chain, potential operator, first passage problems, recurrence-transience, invariant measure, applications.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Lecture notes

SUGGESTED READINGS

– Baldi, P., Mazliak, L., Priouret, P., *Martingales and Markov chains: solved exercises and elements of theory*, Chapman and Hall/CRC, 2002;
– Jacod, J., Protter, P., *Probability essentials*, Springer, 2004;
– Modica, G., Poggiolini, L., *A first course in Probability and Markov chains*, Wiley, 2013;
– Privault, N., *Understanding Markov chains: examples and applications*, Springer, 2013;
– Shiryaev, A. N. , *Probability*, Springer, 1995.

COURSE TAUGHT IN French – English

[MAD] DATA ANALYSIS

PROFESSOR Pierre Dossantos-Uzarralde

MISSION AND CONTEXT Elective course

OBJECTIVES Data analysis is a powerful tool defined as the process of extracting data, analyzing it from many dimensions or perspectives, exploring large complex data sets, including those in very large databases, producing a summary of the information in a useful form that identifies relationships within the data. Data Analysis can be seen as a subject at the crossroads between statistics and computer science. Upon completion of this course, students should be able to think critically about data and apply standard statistical inference procedures to draw conclusions from such analyses. This course will be computationally and mathematically intensive and will use the R language and environment for statistical computing and graphics.

PUBLIC Master level

PREREQUISITES S1-[MPR], S2-[MST]

DURATION 42 hours

ORGANIZATION Course: 11 sessions – Tutorial Classes: 12 sessions – Final Exam: 1 session

CONTENT The principal steps in Data Analysis can be identified as follows:
– Principal Component Analysis (PCA);
– Factorial Correspondence analysis (FCA);
– Multiple Correspondence Analysis (MCA);
– Discriminant Analysis;
– Automatical Classification by Clustering;
– Decisional Discriminant Analysis.

EVALUATION (SESSION 1) Exam (FE) – Lab Sessions (LAB) – Project Report (PR)

EVALUATION (SESSION 2) Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers. Technology Requirements: R statistical software package (free download).

SUGGESTED READINGS – Hastie, T., Tibshirani, R., Friedman, J., *The elements of Statistical Learning: Data Mining, Inference and Prediction*, Springer, 2009.

COURSE TAUGHT IN French – English

TEACHING UNIT

[ANAF] FUNCTIONAL ANALYSIS

PROFESSOR Pierre-Gilles Lemarié-Rieusset

MISSION AND CONTEXT Elective course

OBJECTIVES Introduce students to the properties and analysis in function spaces (infinite dimension) and generalize the usual properties of finite dimensional spaces, thus preparing the analysis of Partial Differential Equations.

PUBLIC Master level

DURATION 42 hours

ORGANIZATION Course: 11 sessions – Tutorial classes: 11 sessions – Final Exam: 1 session

CONTENT Normed vector space, completeness – Continuous linear applications, operator norms – Banach theorems – Riesz representation theorem - Notions of convergence: strong and weak convergence – Optimization in infinite dimension space – Spectral analysis of compact self-adjoint operators.

EVALUATION (SESSION 1) Continuous assessment + Final Exam

EVALUATION (SESSION 2) Final Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture notes

SUGGESTED READINGS

– Brezis, H., *Functional Analysis, Sobolev Spaces and Partial Differential Equations*, Springer, 2011;
– Conway, J. B., *A Course in Functional Analysis*, Springer, 1990;
– Pedersen, G. K., Analysis Now, Springer, 1989;
– Rudin, W., *Functional Analysis*, McGraw Hill, 1991;
– Zimmer, R. J., *Essential Results of Functional Analysis*, University of Chicago Press, 1990.

COURSE TAUGHT IN French – English

[MLG] ADVANCED MODELS IN REGRESSION

PROFESSOR Julien Chiquet

MISSION AND CONTEXT Elective course

OBJECTIVES The course presents the theoretical and practical elements of regression models more sophisticated than the linear model. It aims to provide tools for predicting data as well as approaches that take into account non-linearities. Develop programing and modeling skills in R.

PUBLIC Master level

DURATION 42 hours

ORGANIZATION Course: 12 sessions – Tutorial Classes: 6 sessions - Practical work : 6 sessions

CONTENT The linear model is a central model in the practice of statistics. This course will present extensions of the multiple linear regression model, in particular:
– Logistic regression;
– Generalized linear model;
– Non-parametric regression;
– Model selection;
– R project.

ECTS 4

COURSE TAUGHT IN French – English

SEMESTER 4 S4

COMPULSORY COURSES

ELECTIVE COURSES

TEACHING UNIT

[LVFH4] FOREIGN LANGUAGES AND COMMUNICATION

PROFESSOR Laurence Bourard

MISSION AND CONTEXT Compulsory course

OBJECTIVES The Language modules are designed to help students engage in an increasingly globalized economy and to give them the means to expand their horizons. Students are offered an opportunity to further their spoken and written skills both in English and in another foreign language. The second-year Communication modules focus on business communication strategies.

PUBLIC Master level

PREREQUISITES S1-[LVFH1], S2-[LVFH2], S3-[LVFH3]

DURATION 42 hours

DIVISION LVFH4-M1 – English as a Foreign Language
LVFH4-M2 – Foreign Language
LVFH4-M3 – Communication in Business

ECTS 3

COURSE TAUGHT IN Arabic – Chinese – English – French – German – Italian – Japanese – Portuguese – Russian – Spanish

ENGLISH AS A FOREIGN LANGUAGE [LVFH4-M1]

INSTRUCTOR Laurence Bourard

MISSION AND CONTEXT Compulsory course

OBJECTIVES Enabling students to improve their command of English. Helping them reach the B2 level or C1 level of the Common European Framework of Reference for Languages. Preparing them for a test that certifies their proficiency in the English language (TOEIC or BULATS for example).

PUBLIC Master level

DURATION 17.5 hours

ORGANIZATION Number of periods: 10

EVALUATION (SESSION 1) 20% of the final mark: class attendance (more than 2 unexcused absences will result in a ''0'' score)
40%: continuous assessment (graded coursework)
40%: final examination

EVALUATION (SESSION 2) Depending on the number of students who are allowed to resit, the make-up exam will be either an oral or a written test

COURSE TAUGHT IN English

[LVFH4-M2] FOREIGN LANGUAGES

INSTRUCTOR Isabelle Malefant, Manuel Caldera Bracho, Alberto Suarez Rojas, Yi Starck, Yukiko Fargues, Janna Hermant, Rita Maubert, Christine Cracosky, Karine Bailly, Mahgol Salémi

MISSION AND CONTEXT Compulsory course

OBJECTIVES This module gives students an opportunity to hone their spoken and written skills in another foreign language. ENSIIE offers a choice of 9 language courses: Arabic, Chinese, French, German, Italian, Japanese, Portuguese, Russian, Spanish. The FSL course (French as a Second Language) is designed for international students.

PUBLIC Master level

DURATION 17.5 hours

ORGANIZATION Number of periods: 10

CONTENT Classwork revolves around learner-centered activities based on authentic materials drawn from periodicals, audio/video resources and websites. Small-size groups allow students to develop their language abilities: listening, reading, speaking/interacting and writing skills. Learners are also given access to a language lab and a platform on which they complete different assignments, including practice tests (mostly TOEIC and TOEFL).

EVALUATION (SESSION 1) 20% of the final mark: class attendance (more than 2 unexcused absences will result in a ''0'' score)
40%: continuous assessment (graded coursework)
40%: final examination

EVALUATION (SESSION 2) Written Test

DOCUMENTATION PROVIDED Press articles, music, games.

COURSE TAUGHT IN Arabic – Chinese – French – German – Italian – Japanese – Portuguese – Russian – Spanish

[LVFH4-M3] COMMUNICATION IN BUSINESS

INSTRUCTOR Béatrice Juste, Laurent Prével

MISSION AND CONTEXT Compulsory course

OBJECTIVES The aim of this module is to make students analyze their online reputation and improve their communication strategy. They also have to devise a communication plan that supports a project of their choice.

PUBLIC Master level

DURATION 10.5 hours

ORGANIZATION Number of periods: 6

CONTENT Reputation management. Using the social media. Setting up a communication plan for a specific project (creating a business, for example).

EVALUATION (SESSION 1) 20% of the final mark: class attendance
40%: continuous assessment (graded coursework)
40%: written examination
Two unexcused absences will result in a score of ''0'' for class attendance and students with more than two unexcused absences will receive a 50% deduction in their coursework grade.

EVALUATION (SESSION 2) There is no make-up exam session for this module

COURSE TAUGHT IN French

[EC04] INNOVATIVE CORPORATE PROJECT

PROFESSOR **Sébastien Cauwet**

MISSION AND CONTEXT **Compulsory course**

OBJECTIVES 1) Put into practise classes in management and information technology thanks to an action-based pedagogy. 2) Develop cooperation between manager students and engineer students through mixed teams. 3) Elicit start-up projects and new business ideas. 4) Have students showcase their team's innovative corporate project in a 7-minute video presentation of their business plan.

PUBLIC **Master level – students from ENSIIE, TELECOM SUDPARIS and TELECOM ÉCOLE DE MANAGEMENT**

KEYWORDS *Entrepreneurship, project, start-up*

DURATION **172 hours**

ORGANIZATION Project - Individual coaching course

CONTENT During a full-time week (172 hours), about 100 student teams made of engineering and management students work on innovative corporate projects, especially in the field of ITCs, and have to present a business plan to a panel of judges that are corporate leaders, innovation professionals and faculty members. Students may use an online resource center on the Moodle platform, which enables them to take advantage of the methodology to achieve a business plan, of course documents, of business plan examples, etc. During the week, students alternate between individual coaching courses (including the week-end) and practical classes dedicated to commercial, financial, law, HR aspects, and those of the launching of an innovative start-up, but also to the presentation of a project before investors, and finally to a tool that helps to achieve a business plan (Kerplan software). Teams are helped during the whole compact week (during which nights are short) by experts who coach them for the corporate creation, as well as by campus faculty members, who come to assist the managers of the campus business incubator. the teams with the best projects are asked to present and defend their business plan before a jury composed of partners. The best four projects are declared laureates of « Challenge Projets d'Entreprendre® ».

EVALUATION (SESSION 1) In order to earn the Challenge ECTS points, students must have 10 out of 20, this mark resulting first from the grading of the 7 min video, by campus faculty members (each plan is graded three times), and second from the grading of the student participation to the Challenge week

EVALUATION (SESSION 2) None

DOCUMENTATION PROVIDED Moodle platform, course notes, tutorial notes

SUGGESTED READINGS – Abrams, R., *Successful Business Plan: Secrets & Strategies*, Planning Shop, 2010.

COURSE TAUGHT IN **Conferences are in French but the video, final oral and coaching sessions could be in English**

[ANU] CONCEPTION OF A DIGITAL PIECE OF ART

PROFESSOR Auriane Pichon

MISSION AND CONTEXT Elective course

OBJECTIVES Develop a real sensitivity to the various dynamics that develop between engineers and artists, and have a more creative approach of IT skills, concepts and tools (Arduino, 3D printer, salvage etc.).
2015 theme: interpreting the human / machine relationship:
rethink the uses of technologies mastered by students.

PUBLIC Master level – 15 students

DURATION 42 hours

ORGANIZATION Seminar: 3 sessions – Sites visits: 1 to 2 sessions – Project:
6 to 7 sessions – Oral in front of the jury: 1 session

CONTENT The unit is introduced by a seminar around relationship between the man and the machine: what representations and type of creativity come from the technological development, and what is its impact on everyday life, or on tools and digital items design.
Students will be invited to design their creative project, in a team. This is an opportunity to think a project et use IT tools in the physical world.
Site visits (Gaite Lyrique, Cube), and exhibitons
are programmed to support this approach.

EVALUATION (SESSION 1) Continuous assessment (1/2), project presentation (1/2)

EVALUATION (SESSION 2) None

ECTS 4

COURSE TAUGHT IN French

TEACHING UNIT

[CC] CREATIVE CODING

PROFESSOR Auriane Pichon

MISSION AND CONTEXT Elective course

OBJECTIVES Discover the artistic creative processes linked to the digital world, develop a real sensitivity to the various dynamics that develop between engineers and artists, and address a more creative practice of IT tools. 2015 theme: interpreting the human / machine relationship: rethink the uses of technologies mastered by students.

PUBLIC Master level

DURATION 42 hours

DIVISION CC-M1 – Introduction to arts and digital cultures
CC-M2 – Designing a creative project

ECTS 4

COURSE TAUGHT IN French – English

[CC-M1] INTRODUCTION TO ARTS AND DIGITAL CULTURES

INSTRUCTOR Tomele Jarolim

MISSION AND CONTEXT Elective course

OBJECTIVES Having both a theorical approach on new forms of art and discovering new technics and practices thanks to a collaborative educational project.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 6 sessions

CONTENT Introduction to the theories of digital arts and collaborative cultures. Exhibitions and visits (Numa, Gaîté Lyrique, Cube), meetings with artists. Class activities: each group presents a work/an artist chosen by the speaker to develop the theme. Then the speaker will further explore and expound the topic by engaging participants in an interactive session.

EVALUATION (SESSION 1) Continuous assessment (50%) – project (50%)

EVALUATION (SESSION 2) None

COURSE TAUGHT IN French – English

[CC-M2] DESIGNING A CREATIVE PROJECT

INSTRUCTOR Hervé Pérard

MISSION AND CONTEXT Elective course

OBJECTIVES Learn how to use creative software used by digital artists, explore and analyze a piece of art (its design, format and rendering), grasp the "customers' expectations" of a project through an exchange with the speaker.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 6 sessions

CONTENT Presentation of the software – Testing the issues which come with this type of software – Project: Design a team creative project.

EVALUATION (SESSION 1) Presentation of the project in front of a jury (web or appplication format) + memorandum with references and arguments

EVALUATION (SESSION 2) None

COURSE TAUGHT IN French – English

TEACHING UNIT

[SSI] SYSTEM AND NETWORK SECURITY

PROFESSOR Romain Coltel

MISSION AND CONTEXT Elective course

OBJECTIVES Security is involved into many information technology fields.
This option aims to introduce some basics about IT security. It attempts to go briefly through a wide spectrum of its main topics. Thus students are given the opportunity to dig deeper by themselves in their favorite fields.

PUBLIC Master level

DURATION 42 hours

ORGANIZATION Course: 21 sessions – Tutorial Classes: 2 sessions – Exam: 1 session

CONTENT Cryptography: encryption, authentication, symmetric, asymmetric, hashing, key infrastructures – Network security: Internet supporting protocols (ARP, IP, TCP, DNS), secure network architectures, internals of secured protocols like SSL or Ipsec – System Security: architecture, system security models, security functionality, protections, vulnerabilities, administration and usage good practices, Windows and Linux – Secure Development: main vulnerabilities and mitigations (Web and system).

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

ECTS 4

COURSE TAUGHT IN French – English

TEACHING UNIT

[PCV] CONCURRENT PROGRAMMING AND VERIFICATION

PROFESSOR Gérard Berthelot

MISSION AND CONTEXT Elective course

OBJECTIVES Understanding the intrinsic difficulties of concurrent programming (programming with cooperative threads or processes) and the requirement of verification. Understanding and practice of a model-checker. Design and develop multithreads java applications.

PUBLIC Master level – 28 Students

DURATION 42 hours

DIVISION PCV-M1 – Basic concepts of concurrent programming and verification
PCV-M2 – Concurrent programming with Java

ECTS 4

COURSE TAUGHT IN French – English

[PCV-M1] BASIC CONCEPTS OF CONCURRENT PROGRAMMING AND VERIFICATION

INSTRUCTOR Gérard Berthelot

MISSION AND CONTEXT Elective course

OBJECTIVES Understanding the intrinsic difficulties of concurrent programming (programming with cooperating threads or processes) at the level of data sharing and synchronization. Mastering the widespread tools used to synchronize processes. Acquisition of basic techniques to verify dynamic properties of concurrent programs (deadlock freeness and more advanced properties) using a model-checker.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Lessons: 5 sessions – Tutorial Classes: 3 sessions – Practical work on computer: 4 sessions – Exam: 1 session

CONTENT Why and how to split applications in several processes or threads. The problem of sharing variables or data structures (critical section). Problems of spinning waiting and deadlocks. Well known tools for synchronisation of processes or threads: semaphores, monitors, locks. Learning the SPIN model checker, programming and formula.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

COURSE TAUGHT IN French – English

[PCV-M2] CONCURRENT PROGRAMMING WITH JAVA

INSTRUCTOR	**Gérard Berthelot**
MISSION AND CONTEXT	Elective course
PUBLIC	Master level
DURATION	21 hours
ORGANIZATION	Course: 2 sessions – Tutorial Classes: 2 sessions – Practical work on computer: 6 sessions
CONTENT	Threads java. Design and development of a multithreads java application.
EVALUATION (SESSION 1)	Programming project (SPIN & Java)
EVALUATION (SESSION 2)	Written Exam
COURSE TAUGHT IN	French – English

[SE1] OPERATING SYSTEM 1

PROFESSOR Ivan Augé

MISSION AND CONTEXT Elective course

OBJECTIVES To provide students with the main components of an operating system. What is a computer, an operating system, a kernel, a file system, a device, a toolchain, a boot,...? How these components work closely together.

PUBLIC Master level

DURATION 42 hours

ORGANIZATION Course: 11 sessions – Tutorial Classes: 2 sessions – Practical work: 11 sessions

CONTENT Intel processeurs – Boot – Toolchain – System start – System call and stack management – File system

EVALUATION (SESSION 1) Continuous evaluation

EVALUATION (SESSION 2) None

ECTS 4

COURSE TAUGHT IN French

[SE2] OPERATING SYSTEM 2

PROFESSOR	Ivan Augé
MISSION AND CONTEXT	Elective course
PUBLIC	Master level
PREREQUISITES	S4-[SE1]
DURATION	42 hours
DIVISION	SE2-M1 – Computer Architecture SE2-M2 – Project
ECTS	4
COURSE TAUGHT IN	French

[SE2-M1] COMPUTER ARCHITECTURE

INSTRUCTOR Ivan Augé

MISSION AND CONTEXT Elective course

OBJECTIVES To show the evolution of computer architecture that leads to the efficient computer we use today.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 11 sessions – Final Exam: 1 session

CONTENT CISC – RISC – MMU – Pipeline – Cache.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

COURSE TAUGHT IN French

[SE2-M2] PROJECT

INSTRUCTOR	Ivan Augé
MISSION AND CONTEXT	Elective course
OBJECTIVES	Practical work about UE "Operating System 1" through a full project.
PUBLIC	Master level
DURATION	21 hours
ORGANIZATION	Course: 1 session – Practical work: 11 sessions
CONTENT	Practical work about UE "Operating System 1" through a full project.
EVALUATION (SESSION 1)	Project
EVALUATION (SESSION 2)	None
COURSE TAUGHT IN	French

[RIAL] INTERNET PROTOCOL NETWORKING AND LOCAL AREA NETWORK ADMINISTRATION

PROFESSOR Renaud Rioboo, Ivan Augé

MISSION AND CONTEXT Elective course

OBJECTIVES Understand Internet Protocol (IP) networks from a theoretical and practical point of view. Understanding the tools used by a system engineer and administer a Local Area Network (LAN).

PUBLIC Master level

KEYWORDS TCP, IP, LAN system administration

DURATION 42 hours

ORGANIZATION IP: Course: 3 sessions – Practical Work: 6 sessions
LAN: Course: 4 sessions – Tutorial Classes: 3 sessions – Practical Work: 4 sessions – Final Exam: 1 session

CONTENT LAN part: Administer a local Linux machine – Administer a client machine on a LAN – Design and administer a LAN.
IP part: Architecture and protocols of the internet – Explaining the network layer (IP) of the Internet – Explaining the transport layers (TCP, UDP) of the Internet.

EVALUATION (SESSION 1) LAN: Continuous assessment
IP: written exam (2/3) and continuous assessment (1/3)

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Slides and booklet

SUGGESTED READINGS
– Tannebaum, A., *Computer Networks*, Pearson, 2002;
– Pujole, G., *Les Réseaux*, Eyrolles, 2014.

COURSE TAUGHT IN French

[MFDLS] FORMAL METHODS FOR THE DEVELOPMENT OF RELIABLE SYSTEMS

PROFESSOR Catherine Dubois

MISSION AND CONTEXT Elective course

OBJECTIVES Students will learn ways of specifying, designing, and implementing software correct by construction. The course introduces the B method and its fundamental design method, that is refinement: it allows one to leave out complicated or technical details in the early steps of the development and to introduce them later in a step-by-step manner.
The course also presents another property-based formal environment, FoCaLiZe. Both rely on formal proofs to produce software correct with respect to their specification.
The course also focuses on security properties, like integrity and confidentiality, and access policies.

PUBLIC Master level

KEYWORDS Formal specification, formal design, formal proof, refinement, security, access control

DURATION 42 hours

ORGANIZATION Lectures, exercices, lab sessions

CONTENT Formal specification and formal design of software applications.
Part 1: Logics and set theory (reminders).
Part 2: Formal specification and design (formal specification – refinement – introduction to the B method with its tools Atelier B and ProB – introduction to FoCaLiZe – property-based environment – from informal methods to formal methods – lab sessions).
Part 3: Introduction to security (security properties: integrity, confidentiality – security policies, conformance to security policies – access control: specification of DAC and RBAC policies).
Part 4: industrial applications (usually use of B and Event B in the railway area, presentation done by an industrial).
The project consists in the development of a small application with B.

EVALUATION (SESSION 1) Continuous evaluation (quiz, lab records ....) 50% , project (50%)

EVALUATION (SESSION 2) Exam for 50%, project evaluation kep

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS
– Abrial, J.R., *The B-Book*, Cambridge University Press, 1996;
– Atelier B: http://www.atelierb.eu/;
– Focalize: http://focalize.inria.fr;
– Jha, S., Li, N., Tripunitara, M. ,Wang Q., Winsborough, W. H., *Towards Formal Verification of Role-Based Access Control Policies*, 5 IEEE Trans. Dependable Sec. Comput. 4, 2008, p. 242-255.

COURSE TAUGHT IN French – English

[SIPD1] PRIVACY BY DESIGN INFORMATION SYSTEMS

PROFESSOR Luc Bouganim

MISSION AND CONTEXT Elective course

OBJECTIVES Raise students awareness of privacy-by-design concepts, secure hardware and embedded programming.

PUBLIC Master level – 25 students

KEYWORDS *Privacy, databases, encryption, java, JDBC*

DURATION 42 hours

ORGANIZATION Course: 12 sessions – Practical Work: 12 sessions using the privacy by design platform (lecture + practical work)

CONTENT The goal of this module is triple: (1) to raise students awareness to cyber-security by a practical development of a privacy-by-design application; (2) to bring students to interact with advanced research prototypes (hardware and software) developed in the INRIA SMIS team; (3) to develop a real project in interaction using collaborative tools and environments (6 groups of 4 people interacting using GitLab on the same source code).An initial privacy-by-design data management platform is provided to the students. It contains a hardware device (a USB "token" including a microcontroller, a smartcard, an SD card, a fingerprint reader and a Bluetooth module), embedded software managing securely a database, and a software platform in JAVA providing basic functionalities (storage, communication, encryption). The goal is to build a privacy-by-design application on top of this platform, for instance a secure dropbox or a secure social network. The work is shared between 6 groups who interact through GitLab during the project development.

EVALUATION (SESSION 1) Project

EVALUATION (SESSION 2) None

ECTS 4

DOCUMENTATION PROVIDED Project description, several tutorials on the platform installation and usage

SUGGESTED READINGS

– Bedini, I., Gardarin, G., Nguyen, B., "Semantic Technologies and e-business", in Kajan, E. (ed.), *Electronic Business Interoperability: Concepts, Opportunities and Challenges*, IGI Global Publishing, 2011;
– Allard, T., Anciaux, N., Bouganim, L., Pucheral, P., Thion, R., "Concilier Ubiquité et Sécurité des Données Médicales", in Le Métayer, D. (ed.), *Les technologies de l'information au service des droits : opportunités, défis, limites*, Bruylant, 2010;
– Bouganim, L., Guo, Y., "Database Encryption", in Jajodia, S., Tilborg, H. van (ed.), *Encyclopedia of Cryptography and Security*, Springer, 2009.

COURSE TAUGHT IN French

TEACHING UNIT

[SIPD2] PRIVACY BY DESIGN INFORMATION SYSTEMS

PROFESSOR Luc Bouganim

MISSION AND CONTEXT Elective course

OBJECTIVES Raise students' awareness of privacy-by-design concepts, secure hardware and embedded programming. Precisely, the goal here is to practice selected techniques through course projects. Students having completed this module should be capable of collaborating effectively in teams working on realistic requirements and system design problems.

PUBLIC Master level – 25 students

PREREQUISITES S4-[SIPD1]

KEYWORDS *Privacy, databases, encryption, java, JDBC*

DURATION 42 hours

ORGANIZATION Project development (groups of 4 people, all groups are interacting) with some checkpoints with the teachers – Last session: Project presentation

CONTENT The goal of this module is triple: (1) to raise students awareness to cyber-security by a practical development of a privacy-by-design application; (2) to bring students to interact with advanced research prototypes (hardware and software) developed in the INRIA SMIS team; (3) to develop a real project in interaction using collaborative tools and environments (6 groups of 4 people interacting using GitLab on the same source code). An initial privacy-by-design data management platform is provided to the students. It contains a hardware device (a USB "token" including a microcontroller, a smartcard, an SD card, a fingerprint reader and a Bluetooth module), embedded software managing securely a database, and a software platform in JAVAproviding basic functionalities (storage, communication, encryption). The goal is to build a privacy-by-design application on top of this platform, for instance a secure dropbox or a secure social network. The work is shared between 6 groups who interact through GitLab during the project development.

EVALUATION (SESSION 1) Prepare a Project report on the topic assigned during the lectures

EVALUATION (SESSION 2) None

ECTS 4

DOCUMENTATION PROVIDED Project description, several tutorials on the platform installation and usage

SUGGESTED READINGS

– Bouganim, L., "Data Skew", in Liu, L., Ozsu, T. (ed.), *Encyclopedia of Database Systems*, Springer, 2009, p. 634-635;
– Bouganim, L., "Query Load Balancing in Parallel Database Systems", in Liu, L., Ozsu, T. (ed.), *Encyclopedia of Database Systems, op.cit.*, p. 2268-2272;
– Anciaux, N., Bouganim, L., Pucheral, P., "A Hardware Approach for Trusted Access and Usage Control", in Lian, S., Zhang, Y. (ed.), *Handbook of research on Secure Multimedia Distribution*, IGI Global, 2008, p. 1-24.

COURSE TAUGHT IN French

TEACHING UNIT

[CAL] MODELS OF COMPUTATION

PROFESSOR Renaud Rioboo

MISSION AND CONTEXT Elective course

OBJECTIVES The following questions are raised: what is a program? what is a function? what is a computation? and what are the problems that can or cannot be solved with software. The lecture presents relations (equivalences) between several philosophies and models for computation, namely: Turing machines, partial recursive functions, lambda-calculi. At this point, notions of complexity can be introduced. Eventually we discuss Gödel's first incompleteness theorem.

PUBLIC Master level

DURATION 42 hours

ORGANIZATION Course: 16 sessions – Tutorial Classes: 6 sessions – Practical Work: 2 sessions

CONTENT Turing Machines, decidable/undecidable problems, computability, complexity,recursive functions, lambda-calculus, properties of these models,relations between these models, first incompleteness theorem.

EVALUATION (SESSION 1) Continuous assessment (50%) – Project (50%)

EVALUATION (SESSION 2) None

ECTS 4

COURSE TAUGHT IN French – English

TEACHING UNIT

[MESIM] INTRODUCTION TO MODELING AND SIMULATION

PROFESSOR Pierre Dossantos-Uzarralde

MISSION AND CONTEXT Elective course

OBJECTIVES The training course introduces the students to the simulation methods used in statistics, especially in Bayesian statistics, maximisation methods and quadrature computations in high dimensions which are necessary to deal with complex models used in fields like econometrics, finance genetic, ecology or physics. The lectures provide exposure to areas of application based on the scientific exploitation of the power of computation. Some familiarity with programming in R or similar is recommended.

PUBLIC Master level – 32 students

PREREQUISITES S1-[MPR], S2-[MST]

DURATION 42 hours

DIVISION MESIM-M1 – Simulation Methods
MESIM-M2 – Sequential Monte Carlo, Particle Filtering

ORGANIZATION Course: 12 sessions – Practical Work: 12 sessions

CONTENT Monte Carlo methods – Quasi Monte Carlo – Markov chains reminder – Metropolis-Hastings method – Simulated "recuit" method – Bayesian inference – MCMC methods.

EVALUATION (SESSION 1) Intermediate Exam (IE)

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

COURSE TAUGHT IN French – English

[MESIM-M1] SIMULATION METHODS

INSTRUCTOR Pierre Dossantos-Uzarralde

MISSION AND CONTEXT Elective course

OBJECTIVES The aim of this course is to give a practical introduction to Monte Carlo methods. After completed course, the student should: 1) have a deep theoretical understanding of several Monte Carlo methods; 2) have hands-on experience from implementing and using these techniques; 3) be able carry out simulations in different ensembles; 4) be able to carry out advanced data analysis using, e.g., reweighting; 5) know when to apply the different methods; 6) be able to develop new simulation methods.

PUBLIC Master level – 32 students

PREREQUISITES S1-[MPR], S2-[MST]

KEYWORDS *Bootstrap, sampling, statistics simulations*

DURATION 42 hours

DIVISION

ORGANIZATION Course: 12 sessions – Practical Work: 12 sessions

CONTENT Random Number Generators – Monte Carlo methods – Quasi Monte Carlo – Markov chains reminder – Bayesian inference – MCMC methods

EVALUATION (SESSION 1) Intermediate Exam (IE)

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS
– Bayesian, J. A., Computation with R, Springer, 2009;
– Gobet, E ., *Méthodes de Monte-Carlo et processus stochastiques: du linéaire au non linéaire*, Les Éditions de l'école Polytechnique, 2013;
– Gamerman, D., Lopes, H., *Stochastic Simulation for Bayesian Inference*, Chapman & Hall, 2006.

COURSE TAUGHT IN French – English

[MESIM-M2] SEQUENTIAL MONTE CARLO – PARTICLE FILTERING

INSTRUCTOR Randal Douc

MISSION AND CONTEXT Elective course

OBJECTIVES Particle filtering is becoming increasingly used in various areas, including localization, navigation, tracking, computer vision, mobile robotics, digital communications, etc. An overview of the currently existing algorithms is presented here, within the framework of hidden Markov models.

PUBLIC Master level – 32 students

PREREQUISITES S1-[MPR], S2-[MST]

KEYWORDS *Monte Carlo methods, particle filtering (numerical methods), particle filters*

DURATION 42 hours

ORGANIZATION Course: 12 sessions – Practical Work: 12 sessions

CONTENT Sequential Importance Sampling (SIS) Filter – Bootstrap/SIR Filter – Improved SIS/SIR Filters – Auxiliary Particle Filter – Rejection Particle Filter – Rao-Blackwellization – Kernel Smoothing and Regularization – Data Augmentation – MCMC Particle Filter – Mixture Kalman Filters – Mixture Particle Filters – Other Monte Carlo Filters

EVALUATION (SESSION 1) Intermediate Exam (IE)

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS

– Del Moral, P., *Feynman-Kac Formulae*, Springer, 2004;
– Doucet, A., Freitas, N. de, Gordon, N. (ed.), *Sequential Monte Carlo in Practice*, Springer, 2001;
– Cappé, O., Moulines, É., Ryden, T., *Inference in Hidden Markov Models*, Springer, 2005;
– Liu, J. S., *Monte Carlo Methods in Scientific Computing*, Springer, 2001.

COURSE TAUGHT IN French – English

[ASN] SEMI NUMERICAL ALGORITHMS

PROFESSOR Renaud Rioboo, Christophe Mouilleron

MISSION AND CONTEXT Elective course

OBJECTIVES The class aims at explaining algorithms over big integers and polynomials. It is made of two independent parts, one about numerical algorithms and one about polynomial computations.

PUBLIC Master level

KEYWORDS Big integers, polynomials, arithmetic

DURATION 42 hours

ORGANIZATION Arithmetic: Course : 3 sessions - Tutorial Classes: 4 sessions – Practical Work: 4 sessions – Final Exam: 1 session.
Polynomial arithmetic: Courses : 4 sessions – Tutorial Classes: 3 sessions – Practical Work: 4 sessions – Final Exam: 1 session.

CONTENT Algorithms on big integers, Karatsuba and Tom Cook multiplication – Using the GMP multiprecision library – Polynomial arithmetic with distributed and recursive representation – Resultant computation and its application to symbolic integration

EVALUATION (SESSION 1) Numerical: written exam (2/3) and project (1/3)
Polynomial written exam (2/3) and project (1/3)

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Slides and booklet

SUGGESTED READINGS – Knuth, D. E., *The art of computer programming, Volume 2: Seminumerical Algorithms*, Addison Wesley, 2011.

COURSE TAUGHT IN French

TEACHING UNIT

[RVIG] VIRTUAL REALITY AND COMPUTER GRAPHICS

PROFESSOR Guillaume Bouyer

MISSION AND CONTEXT Elective course

OBJECTIVES To know what are the concepts and the components of Virtual Reality applications, how to design them, how to program visual renderings and 3D user interactions. This option is part of the specialized 2nd year branch "Virtual Reality and Intelligent Systems".

PUBLIC Master level – 40 students

PREREQUISITES S1-[IPI], S1-[ISI]

DURATION 42 hours

DIVISION
RVIG-M1 – Virtual Reality Fundations (Coef. 0,31)
RVIG-M2 – Computer Graphics (Coef. 0,31)
RVIG-M3 – Virtual Reality Project (Coef. 0,38)

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, web sites

COURSE TAUGHT IN French

[RVIG-M1] VIRTUAL REALITY FUNDATIONS

INSTRUCTOR Guillaume Bouyer

MISSION AND CONTEXT Elective course

OBJECTIVES Virtual reality allows users to interact with 3D digital environments in a natural and immersive manner. This module introduces students to this new scientific and technical domain, and presents its founding technological and theoretical principles, including design methods for useful and usable applications and 3D interactions

PUBLIC Master level – 40 students

DURATION 10.5 hours

ORGANIZATION Lecture: 6 sessions – Exam: 1 session

CONTENT VR definitions, history and applications
- Sensori-motor channels; visual, audio, haptic and input interfaces; trackers
- Multimodality and Interaction techniques
- Graphical, audio and haptic rendering techniques

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Lecture slides, web site

SUGGESTED READINGS
- *Le traité de la réalité virtuelle*, Les Presses de L'École des Mines de Paris, 2005;
- Sherman, W. R., Craig, A. B., *Understanding Virtual Reality*, Morgan Kaufmann, 2003.

COURSE TAUGHT IN French

[RVIG-M2] COMPUTER GRAPHICS

INSTRUCTOR	**Jean-Yves Didier**
MISSION AND CONTEXT	Elective course
OBJECTIVES	Present the fundations of computer graphics. Implement a scene graph with the most recent CG techniques (shaders, etc.).
PUBLIC	Master level – 40 students
DURATION	10.5 hours
ORGANIZATION	Lectures: 3 sessions – PW: 3 sessions – Exam: 1 session
CONTENT	Rendering pipeline – Geometry for computer graphics – Scene graph – 3D Modeling – Shaders.
EVALUATION (SESSION 1)	Final Exam (1/2) + Practical work
EVALUATION (SESSION 2)	Written Exam
DOCUMENTATION PROVIDED	Lecture slides, web site
SUGGESTED READINGS	– Shreiner, D., Sellers, G., Kessenich, J. M., Licea-Kane, B. M., *OpenGL Programming Guide*, Addison Wesley, 2013.
COURSE TAUGHT IN	French

[RVIG-M3] VIRTUAL REALITY PROJECT

INSTRUCTOR Guillaume Bouyer

MISSION AND CONTEXT Elective course

OBJECTIVES Students will be expected to implement several techniques as partApply the various concepts and techniques saw during courses with a of the course"game engine (Unity 3D).

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Project: 12 sessions

CONTENT Unity 3D tutorial – Modeling of the virtual environment (scene, cameras, lights...) – Animation – Interactions (selection, manipulation, navigation, control) – Visual feedbacks.

EVALUATION (SESSION 1) Project (technical report + presentation)

SUGGESTED READINGS https://unity3d.com/learn

COURSE TAUGHT IN French

TEACHING UNIT

[ANEDP] ANALYSIS OF PARTIAL DIFFERENTIAL EQUATIONS

PROFESSOR Vincent Torri

MISSION AND CONTEXT Elective course

OBJECTIVES The first part is a theoretical course for solving Partial Differential Equations with abstract existence theorem (Lax-Milgram). The second course is about the finite element methods for computing numerical solutions to PDEs. Some practical and common applications are quantitative finance.

PUBLIC Master level

DURATION 42 hours

DIVISION ANADEP-M1 – Theoretical Analysis of PDEs
ANADEP-M2 – Numerical Analysis PDEs

ECTS 4

COURSE TAUGHT IN French

[ANEDP-M1] THEORETICAL ANALYSIS OF PDES

INSTRUCTOR Julia Matos

MISSION AND CONTEXT Elective course

OBJECTIVES The courses introduce the Lax Milgram theorem for solving PDEs. The proper framework is developed: Hilbert spaces and Sobolev spaces and their properties, in particular Sobolev injections, Poincaré inequality and Reilich theorem.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 6 – Practical Work: 6

CONTENT
– Hilbert spaces;
– Sobolev spaces: generalized derivative, Hk spaces;
– Semi-space case: trace function, regular open sets, fundamental theorems: Sobolev injections, Poincaré inequality, Reilich theorem;
– Boundary limit elliptic problems: Lax Milgram, Dirichlet and Neumanconditions, existence and regularity.

COURSE TAUGHT IN French

[ANEDP-M2] NUMERICAL ANALYSIS OF PDES

INSTRUCTOR Vincent Torri

MISSION AND CONTEXT Elective course

OBJECTIVES To give some experience of the numerical analysis of PDEsn such as finite element methods.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 6 – Practical Work: 5

CONTENT
– Finite elements method;
– Stability and convergence;
– Applications: elliptic equations, heat equation.

COURSE TAUGHT IN French

[CORO] OPERATIONS RESEARCH: TOOLS AND COMPLEMENTS

PROFESSOR Alain Faye

MISSION AND CONTEXT Elective course

OBJECTIVES The objective of this course is to give supplements in linear programming and to give a concrete aspect by modeling problems, implementation methods and use of mathematical programming software.

PUBLIC Master level

PREREQUISITES S3-[MRO]

DURATION 42 hours

ORGANIZATION Course: 14 sessions – Tutorial Classes: 9 sessions – Exam: 1 session

CONTENT The course is composed of three parts: Part 1 – Linear Programming Complements: Duality, Sensitivity Analysis, interior point methods, introduction to linear integer programming, few supplements in OR in the stochastic field; Part 2 – Modeling and computer implementation of OR problem solving: conventional programming, dedicated software as glpk or CPLEX); Part 3 – Large Problem Solving: column generation method: Application to network design, graph partition... IT project and implementation of a concrete problem of optimizing the gas exploitation.

EVALUATION (SESSION 1) Written Exam and case studies

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Partial course notes, Academic papers

SUGGESTED READINGS – Guéret, C., Heipcke, S., Prins, C., Sevaux, M., *Applications of Optimization with XpressMP*, Dash Optimization, 2007.

COURSE TAUGHT IN French

TEACHING UNIT

[IMF] FINANCIAL INSTRUMENTS AND MODELS

PROFESSOR Thomas Lim

MISSION AND CONTEXT Elective course

OBJECTIVES The goal of this course is to present the basic concepts in mathematical finance. The mathematical approach and the market approach are viewed.

PUBLIC Master level

PREREQUISITES S1-[MPR], S3-[ECO-M1]

DURATION 42 hours

DIVISION IMF-M1 – Discrete model in finance
IMF-M2 – Financial instruments

ECTS 4

COURSE TAUGHT IN French – English

[IMF-M1] DISCRETE MODEL IN FINANCE

INSTRUCTOR Étienne Chevalier

MISSION AND CONTEXT Elective course

OBJECTIVES This course introduces the basic concepts in mathematical finance in the discrete case. The first point is the link between no-arbitrage, complete market and risk neutral probability. The second point is the pricing and hedging of claims in the binomial model.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 12 sessions

EVALUATION (SESSION 1) Continuous assessment

EVALUATION (SESSION 2) Written or Oral Exam with financial instruments

COURSE TAUGHT IN French – English

[IMF-M2] FINANCIAL INSTRUMENTS

INSTRUCTOR	**Serge Werle**
MISSION AND CONTEXT	Elective course
OBJECTIVES	Give students some fundamental tools to understand a financial market: 1) ow the price of an asset is fixed; 2) how are used the options to hedge a deal; 3) why there are crises.
PUBLIC	Master level
PREREQUISITES	S3-[ECO3-M1]
KEYWORDS	Equity, bond, stock
DURATION	21 hours
ORGANIZATION	Course: 12 sessions
CONTENT	What is an equity market? How we do an order on a market? Big crisis, OPCVM, Different stocks (bond, equity, derivative,...).
EVALUATION (SESSION 1)	Written Exam
EVALUATION (SESSION 2)	Written or oral exam with discrete model in finance
DOCUMENTATION PROVIDED	Course outline, professor's notes, tutorial notes
SUGGESTED READINGS	– Hull, J. C., *Options, futures and other derivatives*, Prentice Hall, 2014.
COURSE TAUGHT IN	French – English

TEACHING UNIT

[MCS] STOCHASTIC CALCULUS

PROFESSOR Étienne Chevalier

MISSION AND CONTEXT Elective course

OBJECTIVES This UE introduces fundamental mathematical concepts that are applied in many fields, especially in economy and finance. For instance, stochastic calculus is widely used for portfolio management, pricing and hedging derivatives. This UE is essential for students who wish to work in finance and financial engineering.

PUBLIC Master level

DURATION 42 hours

ORGANIZATION Course: 17 sessions – Tutorial Classes: 7 sessions

CONTENT Continuous stochastic process: markov property, martingales, gaussian process. Brownian motion, Itô calculus, Stochastic Differential Equations, Girsanov Theorem, Applications: Standard financial model (Black and Scholes).

EVALUATION (SESSION 1) Continuous assessment

EVALUATION (SESSION 2) Written Exam

ECTS 4

COURSE TAUGHT IN French

TEACHING UNIT

[MOST] STATISTICAL MODELING

PROFESSOR Marie Szafranski

MISSION AND CONTEXT Elective course

OBJECTIVES This course presents a set of methods for the discovery of existing relations between the response and the variables of a random phenomenon. The various issues of modeling (analysis and / or prediction of the phenomenon) will be studied in the framework of supervised classification and regression.

PUBLIC Master level – 28 students

DURATION 42 hours

DIVISION MOST-M1 – Introduction to Machine Learning
MOST-M2 – Time Series

COURSE TAUGHT IN French – English

[MOST-M1] INTRODUCTION TO MACHINE LEARNING

INSTRUCTOR Jean-Christophe Jarmodet, Agathe Guilloux

MISSION AND CONTEXT Elective course

OBJECTIVES Machine learning gathers a set of methods designed to analyze, interpret or predict a phenomenon. This course aims to provide some theoretical and practical elements of machine learning in the context of the supervised classification.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 7 sessions – Practical Work: 5 sessions

CONTENT The course is an introduction to supervised machine learning.
It is organized as follows:
– Introduction to machine learning: empirical risk, structural risk, generalization error, etc.;
– Methodology of machine learning: evaluation of the error;
– Methods: K nearest neighbors, decision trees, boosting and SVM.

EVALUATION (SESSION 1) Continuous assessment (1/3), project (2/3)

SUGGESTED READINGS – Hastie T., Tibshirani R., Friedman J., *Elements of Statistical Learning: Data Mining, Inference and Prediction*, Second Edition, 2009.

COURSE TAUGHT IN French – English

[MOST-M2] TIMES SERIES

INSTRUCTOR	**Mohammadu Seck**
MISSION AND CONTEXT	Elective course
OBJECTIVES	In this course, we study the properties of the linear time series and the ways of estimating and forecasting these series.
PUBLIC	Master level
DURATION	21 hours
ORGANIZATION	Course: 7 sessions – Practical Work: 5 sessions
CONTENT	Linear time series: Auto Regressive (AR) processes, Moving average (MA), ARMA, ARIMA, and their applications.
EVALUATION (SESSION 1)	Project (50%) – Final Exam (50%)
EVALUATION (SESSION 2)	Written Exam
COURSE TAUGHT IN	French – English

[PRB] PATTERN RECOGNITION AND BIOMETRICS

PROFESSOR	Sonia Garcia
MISSION AND CONTEXT	Elective course
OBJECTIVES	To master the tools for pattern recognition and data classification. To know biometric modalities' specific techniques. To be able to implement a biometric system of identity verification.
PUBLIC	Master level
PREREQUISITES	S1-[MPR], S2-[MST]
DURATION	42 hours
ORGANIZATION	Course: 7 sessions – Labs: 8 sessions – Project: 9 sessions
CONTENT	Bayes Rule – Supervised Learning – Unsupervised Learning: Clustering techniques, Mixtures of Gaussians – Hidden Markov Models – Applications to different biometric modalities: iris, face, gait, online signature, voice.
EVALUATION (SESSION 1)	Exam (FE) / Lab Sessions (LAB) and Project Report (PR) Final Grade: 1/4 FE + 1/4 LAB + 1/2 PR
EVALUATION (SESSION 2)	Oral exam
ECTS	4
COURSE TAUGHT IN	French – English

SEMESTER 5 S5

COMPULSORY COURSES

ELECTIVE COURSES

TEACHING UNIT

[TCEFH] HUMAN SCIENCES AND MANAGEMENT

PROFESSOR Guillaume Burel

MISSION AND CONTEXT Compulsory course

OBJECTIVES This UE aims at showing the impact of IT in the operation and organization of the company and its business, as well as more widely in the world, society and history.

PUBLIC Master level

DURATION 42 hours

DIVISION TCEFH -M1 – Project Management
TCEFH -M2 – IT Marketing

ECTS 3

COURSE TAUGHT IN French

[TCEFH-M1] PROJECT MANAGEMENT

INSTRUCTOR Guillaume Burel

MISSION AND CONTEXT Compulsory course

OBJECTIVES To master the conditions of framing and of mobilization of useful contributions to support a project, from conception to implementation and measurement of its results.

PUBLIC Master level

DURATION 14 hours

ORGANIZATION Course: 8 sessions

CONTENT What methodology of project management.
How to determine challenges and strategic prospects of a project.
How to anticipate risks and opportunities of a project.
How to detect allies (sociodynamics).
How to define the flow of a project (approach, operational goals/smart tasks, co-construction of a planning).
How to build a active team in the best condition to contribute to the project.
How to report effectively and efficiently.
How to communicate as a Project Manager and how to negotiate the necessary changes.
How to maintain engagement on a project, show quick gains...

EVALUATION (SESSION 1) Continuous assessment

EVALUATION (SESSION 2) None

COURSE TAUGHT IN French

[TCEFH-M2] MARKETING

INSTRUCTOR Ilan Khalifa

MISSION AND CONTEXT Compulsory course

OBJECTIVES To discover the marketing and internet marketing from an operational point of view. To implement a business strategy and especially control levers to achieve ROI.

PUBLIC Master level

DURATION 14 hours

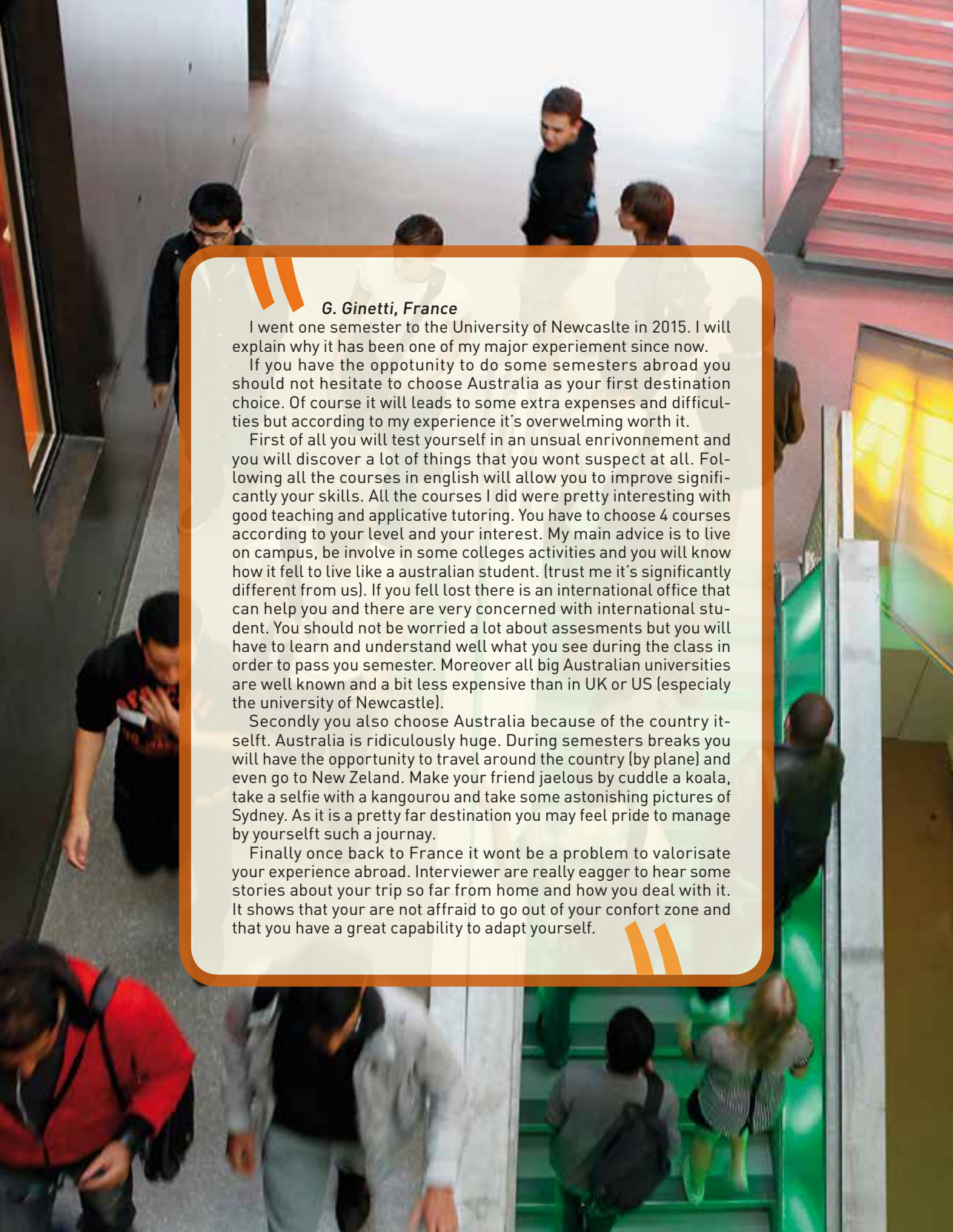
ORGANIZATION Course: 8 sessions

CONTENT Recalling on marketing (marketing mix, market concept, strategy).
Internet marketing (fundamentals, goals, acquisition cost, the long tail – an effective website: prerequisites, B2B vs. B2C – making visitors come back: community, viral marketing – search engines: Introduction to SEO – email – banners – analytics).
Internationalization strategy (introduction and international environment, strategic management and internationalization, implementing a strategy of internationalization, financing the internationalization, control organization and multicultural management).

EVALUATION (SESSION 1) Practical Work – Oral Presentation

EVALUATION (SESSION 2) None

COURSE TAUGHT IN French



G. Ginetti, France

I went one semester to the University of Newcaslte in 2015. I will explain why it has been one of my major experiement since now.

If you have the oppotunity to do some semesters abroad you should not hesitate to choose Australia as your first destination choice. Of course it will leads to some extra expenses and difficulties but according to my experience it's overwelming worth it.

First of all you will test yourself in an unsual enrivonnement and you will discover a lot of things that you wont suspect at all. Following all the courses in english will allow you to improve significantly your skills. All the courses I did were pretty interesting with good teaching and applicative tutoring. You have to choose 4 courses according to your level and your interest. My main advice is to live on campus, be involve in some colleges activities and you will know how it fell to live like a australian student. (trust me it's significantly different from us). If you fell lost there is an international office that can help you and there are very concerned with international student. You should not be worried a lot about assesments but you will have to learn and understand well what you see during the class in order to pass you semester. Moreover all big Australian universities are well known and a bit less expensive than in UK or US (especialy the university of Newcastle).

Secondly you also choose Australia because of the country itselft. Australia is ridiculously huge. During semesters breaks you will have the opportunity to travel around the country (by plane) and even go to New Zeland. Make your friend jaelous by cuddle a koala, take a selfie with a kangourou and take some astonishing pictures of Sydney. As it is a pretty far destination you may feel pride to manage by yourselft such a journay.

Finally once back to France it wont be a problem to valorisate your experience abroad. Interviewer are really eagger to hear some stories about your trip so far from home and how you deal with it. It shows that your are not affraid to go out of your confort zone and that you have a great capability to adapt yourself.

TEACHING UNIT

[RIIA] INFORMATION RETRIEVAL AND ARTIFICIAL INTELLIGENCE

PROFESSOR Anne-Laure Ligozat

MISSION AND CONTEXT Elective course

OBJECTIVES Due to the rapidly increasing amount of information published with different media, knowing what tools can access and treat it becomes crucial. The objective of this course is to present the models and tools in information retrieval, for texts and images, and the associated machine learning methods.

PUBLIC Master level

DURATION 42 hours

DIVISION RIIA-M1 – Multimedia Information Retrieval
RIIA-M2 – Machine Learning

ECTS 5

COURSE TAUGHT IN French – English

[RIIA-M1] MULTIMEDIA INFORMATION RETRIEVAL

INSTRUCTOR Marin Ferecatu, Brigitte Grau, Anne-Laure Ligozat

MISSION AND CONTEXT Elective course

OBJECTIVES The objective of this module is to present the main models in Information Retrieval (IR), that represent the bases of search engines (for texts and images) and basic and advanced techniques for text-based information systems. This course covers models for techniques for indexing and searching, algorithms for classification and clustering, latent semantic indexing, link analysis and ranking.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 6 sessions - Practical Work: 6 sessions

CONTENT Textual IR : IR models, evaluation and web IRImage retrieval :
– Paradigms for Image retrieval;
– Describing visual content;
– Mining large multimedia collections and index structures;
– Similarity based retrieval and mining.

EVALUATION (SESSION 1) Computer exercises, term project

EVALUATION (SESSION 2) Written Exam

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS – Manning, C. D., Raghavan, P., Schütze, H., *Introduction to Information Retrieval*, Cambridge University Press, 2008.

COURSE TAUGHT IN French - English

BASED Évry

[RIIA-M2] MACHINE LEARNING

INSTRUCTOR Benjamin Piwowarski

MISSION AND CONTEXT Elective course

OBJECTIVES This course introduces several fundamental concepts and methods for machine learning.The objective of this module is to present the main models of Machine Learning (ML). Severalsoftware libraries and data sets publicly available will be used to illustrate the application of these algorithms. The models will be applied to information retrieval and mining problems. The students will be able to understand the basic theory underlying machine learning, to aply machine learning algorithms to solve problems of moderate complexity, to read current research papers and understand the issues raised by current research.

PUBLIC Master level

DURATION 21 hours

CONTENT Introduction: ML tasks – Theoretical and empirical risks – Conducting experiments – ML models (I): K-nearest neighbors and K-means – Decision trees.
Optimization: gradient descent – ML models (II): Probabilistic graphical models – Neural networks – Perceptron – Multi-layer networks – Representation Learning

EVALUATION (SESSION 1) Computer exercises, term project

EVALUATION (SESSION 2) None

ECTS 4

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

SUGGESTED READINGS – Hastie T., Tibshirani, R., Friedman, J., *The Elements of Statistical Learning: Data Mining, Inference and Prediction*, Springer, 2011;
– Yaochu, J. (ed.), *Multi-Objective Machine Learning*, Springer, 2006.

COURSE TAUGHT IN French - English

BASED Évry

TEACHING UNIT

[MQF1] COMPUTATIONAL FINANCE

PROFESSOR Stéphane Crepey

MISSION AND CONTEXT Elective course

OBJECTIVES The course bears on the modeling and numerical analysis of financial derivatives. The objectives are:
1) Understanding the financial meaning of the related mathematics: model parameters, implied volatility, Greeks;
2) Learning how to derive a pricing equation based on the probabilistic formulation of a model, possibly with stochastic volatility and/or jumps;
3) Learning how to implement a theta-scheme of finite differences or a tree pricing method;
4) Learning simulation Monte Carlo pricing and Greeking methods: basic principles and variance reduction techniques, first in a set-up of random variables or vectors, then in a dynamic set-up of stochastic processes.

PUBLIC Master level

DURATION 42 hours

CONTENT 1) Motivating examples: Black-Scholes and Dupire model, Realized volatility vs Implied volatility vs Local volatility;
2) Derivation of the Pricing Equations in various models;
3) Deterministic Pricing Schemes: Finite Differences methods and Tree Methods;
4) Simulation Pricing Schemes: simulation of random variables and stochastic processes, Pseudo Monte Carlo versus Quasi Monte Carlo, variance reduction techniques.

EVALUATION (SESSION 1) Final Exam

EVALUATION (SESSION 2) None

ECTS 5

SUGGESTED READINGS

– Crépey, S., *Financial Modeling*, Springer, 2013, chapters 5-9;
– Lamberton, D., Lapeyre P., *Introduction to Stochastic Calculus Applied to Finance*, Chapman & Hall, 2007;
– Shreve, S., *Stochastic Calculus for Finance II: Continuous-Time Models*, Springer, 2004;
– Cont, R., Tankov, P., *Modelling with Jump Processes*, Chapman & Hall, 2003;
– Glasserman, P., *Monte Carlo Methods in Financial Engineering*, Springer, 2004;
– Hull, J., *Options, Futures and Other Derivative Securities*, Prentice-Hall, 2009.

COURSE TAUGHT IN French

BASED Évry

[OPTI1] OPTIMIZATION 1

PROFESSOR Alain Faye

MISSION AND CONTEXT Elective course

OBJECTIVES Give students the essential bases (in addition to those that were acquired in previous years) to address a theoretical or industrial optimization problem. To acquire some expertise in this area, it is strongly advised that you take, after this rather theoretical course, the application-oriented course "Optimization-2".

PUBLIC Master level

PREREQUISITES S3-[MRO]

DURATION 42 hours

DIVISION
OPTI1-M1 – Computational Complexity
OPTI1-M2 – Operations Research
OPTI1-M3 – Polyhedral Methods

ECTS 5

SUGGESTED READINGS
– Nemhauser, G. L., Wolsey L. A., *Integer and Combinatorial Optimization*, Wiley & Sons, 1988;
– Wolsey, L. A., *Integer Programming*, Wiley & Sons, 1998.

COURSE TAUGHT IN French

BASED Évry

[OPTI1-M1] COMPUTATIONAL COMPLEXITY

INSTRUCTOR Alain Faye

MISSION AND CONTEXT Elective course

OBJECTIVES The course seeks to make students aware of the concept of « efficiency of an algorithm » and then to teach them to distinguish between "easy" problems and "difficult" problems in order to guide the search for ways to resolve them.

PUBLIC Master level

DURATION 12,25 hours

ORGANIZATION Course: 6 sessions – Exam: 1 session

CONTENT Analysis of algorithms. Efficiency of algorithms. Input encoding, size of an instance. Polynomial-, pseudo-polynomial-, and non polynomial-time algorithms. The classes P, NP and co-NP. Polynomial-time reductions. NP-complete and NP-Hard problems. Space complexity. Some ideas about approximation algorithms and approximation schemes.

EVALUATION (SESSION 1) Written Exam with course notes

EVALUATION (SESSION 2) Written Exam with course notes

COURSE TAUGHT IN French

BASED Évry

[OPTI1-M2] OPERATIONS RESEARCH

INSTRUCTOR Alain Faye

MISSION AND CONTEXT Elective course

OBJECTIVES Develop the most useful techniques of operations research and put in practice some of these techniques.

PUBLIC Master level

DURATION 14 hours

ORGANIZATION Lectures: 7 sessions – Examination: 1 session

CONTENT Continuous linear programming. Integer linear and non linear programming. Lagrangian duality. Modelling of combinatorial optimization problems (linear and non linear) in areas such as telecommunications, transportations and sustainable development.

EVALUATION (SESSION 1) Written Exam with course notes

EVALUATION (SESSION 2) Written Exam with course notes

COURSE TAUGHT IN French

BASED Évry

[OPTI1-M3] POLYHEDRAL METHODS

INSTRUCTOR Alain Faye

MISSION AND CONTEXT Elective course

OBJECTIVES Obtain a "good" model of a combinatorial optimization problem. Many combinatorial optimization problems can be formulated by integer linear programs. To solve them efficiently it is often necessary to refine the basic model. This is achieved, in particular, by searching for and adding efficient valid inequalities.

PUBLIC Master level

DURATION 15,75 hours

ORGANIZATION Lectures: 4 sessions – Tutorials: 4 sessions – Examination: 1 session

CONTENT Valid inequalities. Various approaches to get valid inequalities: Chvatal-Gomory cuts and disjunctives inequalities. Valid inequalities in mixed-integer variables. Faces and facets of a polyhedron. Valid inequalities inducing facets. Cut-generation algorithm and the separation problem. Benders' cuts. Exercises and examples.

EVALUATION (SESSION 1) Written Exam with course notes

EVALUATION (SESSION 2) Written Exam with course notes

COURSE TAUGHT IN French

BASED Évry

[OPTI2] OPTIMIZATION 2

PROFESSOR Dimitri Watel

MISSION AND CONTEXT Elective course

OBJECTIVES Modern techniques of operations research apply to many areas. We chose the first module of this option to present and illustrate many of these techniques on a growing field: optimizing networks (telecommunications, IT, transport, etc.). The second module is primarily intended to introduce students to the implementation of computer models of operational research, a very important aspect of this discipline.

PUBLIC Master level

PREREQUISITES S3-[MRO], S5-[OPTI1]

DURATION 42 hours

DIVISION OPTI2-M1 – Design and Network Optimization
OPTI2-M2 – Case Study

ECTS 5

SUGGESTED READINGS
– Billionnet, A., *Optimisation Discrète*, Dunod, 2007;
– Hêche, J.-F., Liebling, T. M., De Werra, D., *Recherche Opérationnelle pour ingénieurs*, volumes 1 and 2, PPUR, 2003;
– Hillier, F., *Introduction to Operations Research*, McGraw Hill, 2015.

COURSE TAUGHT IN French

BASED Évry

[OPTI2-M1] DESIGN AND NETWORK OPTIMIZATION

INSTRUCTOR Sourour Elloumi

MISSION AND CONTEXT Elective course

OBJECTIVES This course has two objectives:
1. Consider some design problems and optimization in networks, such as the problems of locating equipment, sizing and routing. These often difficult problems arise in many areas (IT, telecommunications, etc.).
2. Use these problems to illustrate the concepts and tools of practical resolution of combinatorial optimization problems of large size.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 11 sessions – Exam: 1 session

CONTENT Exact solution by use of mathematical programming, concept of good formulation, the concept of relaxation, resolution etc. Approximate solution by different types of heuristics: constructive heuristics, local search and meta-heuristics.

EVALUATION (SESSION 1) Written Exam with documentation

EVALUATION (SESSION 2) Written Exam with documentation

DOCUMENTATION PROVIDED Partial course notes, Academic papers

COURSE TAUGHT IN French

BASED Évry

[OPTI2-M2] CASE STUDY

INSTRUCTOR Dimitri Watel

MISSION AND CONTEXT Elective course

OBJECTIVES Three objectives:
Know execute different phases of an optimization project: formulation of the problem, constructing a mathematical model to represent the studied system, model resolution and study of the resulting solution.
Implement the main methods of operations research (mathematical programming, specific branch and bound, metaheuristics).
Use of professional optimization software.

PUBLIC Master level

DURATION 21 hours

ORGANIZATION Course: 11 sessions – Exam: 1 session

CONTENT Different topics are offered to students each year. They illustrate the various concepts and algorithms presented in the sub-modules of the optimization options 1 and 2. Implementation is partly based on the use of professional optimization software.

EVALUATION (SESSION 1) Project

DOCUMENTATION PROVIDED Partial course notes, training and practice exercises

COURSE TAUGHT IN French

BASED Évry

[PROG1] SEMANTICS OF PROGRAMMING LANGUAGES

PROFESSOR Catherine Dubois

MISSION AND CONTEXT Elective course

OBJECTIVES Deductive formal methods use formal proof as a major component. This module presents the fondations of such methods and related tools, in particular the correspondance between proofs and programs, between specifications and types. Many program verification or static analysis tools exist, they rely on a precise definition of the semantics of the programmning language used tto write these programs.The module focuses, in a second part, on the techniques used to provide such precise and mathematical definition of the semantics.

PUBLIC Master level – 25 students

PREREQUISITES S1-[IPI], S1-[IPF], S1-[logics]

DURATION 42 hours

ORGANIZATION Formal proof (notation coef. 2):
11 lecture sessions – 4 lab. sessions – 1 exam session.
SL – Semantics of programming languages (coef 1):
5 lecture sessions – 2 lab. sessions – 1 exam session

CONTENT From propositional logics to higher order logics, lambda calculus, typetheory (simply typed lambda calculus, dependant types),correspondance between proofs and programs, formal proof, proofassistant, introduction to the proof assistant Coq, decisionprocedure, rewriting, completion procedure.Semanticsof programming languages, operational semantics, natural semantics,formalisation of a small imperative language, formalisation of afunctional language, formalisation of some object oriented features.Implementation of interpreters in Ocaml and with K.

ECTS 5

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

COURSE TAUGHT IN French – English

BASED Évry

TEACHING UNIT

[MQS] QUANTITATIVE METHODS AND STATISTICS

PROFESSOR	**Thomas Lim**
MISSION AND CONTEXT	Elective course
PUBLIC	Master level
PREREQUISITES	S1-[MPR], S4- [MNS], S3-[ECO3-M1], S4-[MCS], S4-[IMF-M1], S4-[IMF-M2]
DURATION	50 hours
DIVISION	**MQS-M1** – Interest Rate Model **MQS-M2** – Non Parametric Statistics
ECTS	5
COURSE TAUGHT IN	French – English
BASED	Évry

[MQS-M1] INTEREST RATE MODEL

INSTRUCTOR Thomas Lim

MISSION AND CONTEXT Elective course

OBJECTIVES The interest rate are used in many area in finance. For example to get the price of a zero-coupon bond, to hedge a call option,... So you must know the value of the interest rate for any time. But the value is not sufficient since you need know the correlation between the pay-off and the interest rate, so you must know the diffusion of this one.
The objective are:
1) Understanding the utility of interest rates;
2) How we can model these ones;
3) What is a good model;
4) Price with a model.

PUBLIC Master level

PREREQUISITES S1-[MPR], S4-[MCS]

DURATION 21 hours

ORGANIZATION Course: 12 sessions

CONTENT In this course we study the classical short rate model (Vasicek model, Hull-White model, Cox-Ingersoll-Ross model): diffusion, price under the different models. We also study the Heath-Jarrow-Morton model, and give the link between short rate model and Heath-Jarrow-Morton model. We finish with the LIBOR market.

EVALUATION (SESSION 1) Written Exam

EVALUATION (SESSION 2) Written or oral exam

DOCUMENTATION PROVIDED Lectures slides

SUGGESTED READINGS – Filipovic, D., *Term-Structure Models: A graduate course*, Springer, 2009.

COURSE TAUGHT IN French – English

BASED Évry

[MQS-M2] DURATION MODELS

INSTRUCTOR Marie-Luce Taupin

MISSION AND CONTEXT Elective course

OBJECTIVES Understanding the stakes and the statistical methods of survival analysis.

PUBLIC Master level

PREREQUISITES S2-[MST], S3-[PST]

KEYWORDS *Survival analysis, nonparametric and semiparametric inference, censoring*

DURATION 21 hours

ORGANIZATION Course: 6 sessions – Tutorial Classes: 6 sessions

CONTENT
– Applications in medecine, reliability, insurance;
– Survival function, censoring;
– Kaplan Meier estimator;
– Comparison test for survival function;
– Semi parametric methods;
– Cox regression;
– Variable selection.

EVALUATION (SESSION 1) Practical Work –Project –Final Exam

EVALUATION (SESSION 2) Written Exam

SUGGESTED READINGS
– Andersen, P. K., Borgan, O., Gill, R. D., Keiding, N., *Statistical models based on counting pr ocess*, Springer, 2012.

COURSE TAUGHT IN French – English

BASED Évry

[MCS2] ADVANCED STOCHASTIC CALCULUS

PROFESSOR Shiqi Song

MISSION AND CONTEXT Elective course

OBJECTIVES The goal of this UE is of two folds. On the one hand, for the students in mathematical finance, this UE gives an introduction to exponential Lévy model. The students will learn at a first time about the Lévy processes and will be asked to read original research papers. Based on this knowledge, the students will study various issues of exponential Lévy models including no-arbitrage property, option pricing formula, quadratic hedging strategy, model calibration problem. It is a typical market model with jump processes. The study of the model requires the students to acquire the advanced stochastic calculus. On the other hand, this UE results in writing of reports. The report constitutes not only the demonstration of a good mastery of the theory, but also a test of writing skill. The students are required to learn rules of mathematic writing and to produce reports conforming to the standard of research paper.

PUBLIC Master level

KEYWORDS *Semimartingale calculus, triplet of local characteristics, Ito's formula,integration by parts formula, stochastic differential equation, stochastic exponential, Lévy process, Lévy measure, Lévy-Khintchine's formula, Esscher transform, Poisson point process, subordinator, no-arbitrage, option, quadratic hedging, minimal martingale measure*

DURATION 42 hours

ORGANIZATION Course: 20 sessions – Practical classes: 4 sessions

CONTENT A quick review of the stochastic calculus of semimartingales – An introduction to Lévy processes – A presentation of Lévy exponential models through the themes: no-arbitrage property, option pricing formulas, model calibration – Lectures and discussions on original papers about Lévy exponential models.

EVALUATION (SESSION 1) Class presentations, oral tests and projects

EVALUATION (SESSION 2) None

ECTS 5

DOCUMENTATION PROVIDED Course notes, academic papers

SUGGESTED READINGS
– Appelbaum D., *Lévy Processes and Stochastic Calculus*, Cambridge University Press, 2004;
– Cont R., Tankov, P., *Financial Modelling with Jump Processes*, CRC Press, 2004;
– Dellacherie, C., Meyer, A.P., *Probabilités et Potentiel*, Hermann, 1975-1992, chapters I-XXIV;
– He, S. W, Wang, J. G., Yan, J. A., *Semimartingale Theory and Stochastic Calculus*, CRC Press, 1992;
– Jacod, J., *Calcul Stochastique et Problèmes de Martingales*, Spinger, 1979.

COURSE TAUGHT IN French - English

BASED Évry

TEACHING UNIT

[MSA] ADVANCED STATISTICAL MODELING

PROFESSOR Nicolas Brunel

MISSION AND CONTEXT Elective course

OBJECTIVES The main objective of this course is to develop the skills needed to do empirical research in fields operating with time series data sets. This course is given to final-year graduates who have studied at least two courses covering basic probability and statistical inference. This course will provide you with the basic theory and tools for the statistical analysis and interpretation of Statistical Modeling.

PUBLIC Master level

PREREQUISITES S1-[MPR], S1-[MST]

DURATION 42 hours

DIVISION MSA-M1 – Times Series with Latent Variables
MSA-M2 – Nonparametric Statistics

ORGANIZATION Course: 14 sessions - Pratical Work: 9 + Final Exam

CONTENT At the end of the teaching unit the student must: 1) be able to find suitable stochastic models for financial data; 2) work with stochastic calculus for pricing of financial contracts and for transforming models so that data becomes suitable for stochastic modelling; 3) understand when and how filtering methods should be applied, validate a chosen model in relative and absolute terms; 4) solve all parts of a modelling problem using financial and statistical theory (from this course and from other courses) where the solution includes model specification, inference, and model choice; 5) present the solution in a written technical report, as well as orall; 6) use scientific articles within the field and related fields.

ECTS 5

SUGGESTED READINGS

– Casella, G., Berger, R. L., *Statistical Inference*, Duxbury Press, 2001;
– Burnham, K. P., Anderson, D. R., *Model Selection and Multimodel Inerence: A Practical Information-Theoretic Approach*, Springer, 2002;
– Gelman, A., *et al.*, Bayesian *Data Analysis*, Chapman and Hall/CRC, 2013;
– Gelman, A., Hill, J., *Data Analysis Using Regression and Multilevel/Hierarchical Models*, Cambridge

COURSE TAUGHT IN French - English

BASED Évry

[MSA-M1] TIMES SERIES WITH LATENT VARIABLES

INSTRUCTOR	**Arnaud Gloter**
MISSION AND CONTEXT	Elective course
OBJECTIVES	Time series Modeling with hidden / latent variables, and introduce and develop their use in particular in finance, with some examples in Scilab.
PUBLIC	Master level
DURATION	21 hours
ORGANIZATION	Course: 8 sessions – Pratical Work: 4 sessions
CONTENT	At the end of the course, the student must: 1) handle variance models such as the GARCH family, stochastic volatility, and models used for high-frequency data; 2) use basic tools from stochastic calculus: Itô's formula, transformation, martingales, Markov processes, filtering; 3) use tools for filtering of latent processes, such as Kalman filters and particle filters,
EVALUATION (SESSION 1)	Pratical work + Final Exam
EVALUATION (SESSION 2)	Final Exam
DOCUMENTATION PROVIDED	Partial course notes, Academic papers
SUGGESTED READINGS	– Hamilton, J. D., *Time Series Analysis*, Princeton University Press, 1994.
COURSE TAUGHT IN	French - English
BASED	Évry

[MSA-M2] NONPARAMETRIC STATISTICS

INSTRUCTOR Sandra Plancade

MISSION AND CONTEXT Elective course

OBJECTIVES Course develops students' abilities to assess the appropriateness of parametric or nonparametric methods for a given statistical problem. It will provide you with the basic theory and computing tools to perform nonparametric tests including the sign test, Wilcoxon signed rank test, and Wilcoxon rank sum test, as well as the correspondingnonparametric point and interval estimation. Kruskal-Wallis and Friedman tests for one-way and two-way analysis of variance, multiplecomparisons, dispersion and independence problems are other nonparametric tests covered.Other topics include estimation methods for nonparametric density, regression, and computing as they relate to nonparametric statistics.

PUBLIC Master level

PREREQUISITES S1-[MST]

DURATION 21 hours

ORGANIZATION Course: 6 sessions – Pratical Work: 6 sessions

CONTENT Estimation of the cumulative distribution function – Comparison tests – Density estimation – Regression estimation – Nonparametric regression

EVALUATION (SESSION 1) Pratical work

EVALUATION (SESSION 2) Written Exam

DOCUMENTATION PROVIDED Partial course notes, Academic papers

SUGGESTED READINGS
– Sprent, P., *Applied Nonparametric Statistical*, Chapman and Hall, 2000;
– Higgins, J. V., *Introduction to Modern Nonparametric Statistics*, Duxbury Press, 2003.

COURSE TAUGHT IN French - English

BASED Évry

TEACHING UNIT

[PROG2] SEMANTICS OF PROGRAMMING LANGUAGES

PROFESSOR Catherine Dubois, Virgile Prevosto, Julien Signoles

MISSION AND CONTEXT Elective course

OBJECTIVES Static analysis determines information about program at compile time while dynamic analysis, such as testing, determines information about a program during its execution. This course complements techniques introduced in S3-[VVL] (Hoare Logics) and presents techniques for computing approximate information about a program (value analysis, dataflow analysis etc.) that can be useful in different applications such as compilation, verification of security or safety properties, debugging etc. Another major component of the course is a program analysis implementation project.

PUBLIC Master level – 25 students

PREREQUISITES S1-[IPI], S1-[IPF], S1-[logics], S5-[PROG1]

DURATION 42 hours

ORGANIZATION Static Analysis of Software (notation 50%) – Project/Development (50%) – 10 lecture sessions – 2 lab. sessions – 2 exam sessions
PR – Project/Development (notation 50%) - 6 lab. sessions – 4 sessions dedicated to presentations and project defense

CONTENT Semantics, non standard semantics, abstract interpretation: fixpoints, lattices, Galois connections, correcness of a static analysis with respect to semantics, illustration with the FramaC plateform.

ECTS 5

DOCUMENTATION PROVIDED Lecture slides, partial course notes, academic papers

COURSE TAUGHT IN French – English

BASED Évry

TEACHING UNIT

[MAL] MACHINE LEARNING

PROFESSOR Nicolas Brunel

MISSION AND CONTEXT Elective course

OBJECTIVES This is an introductory-level course in supervised learning. This course includes two modules one in data mining and one in machine learning. Some unsupervised learning methods are discussed: principal components and clustering (k-means and hierarchical). We focus on what we consider to be the important elements of modern data analysis. Data mining and Machine learning are the interdisciplinary statistics and computer science which develop such statistical models and interweave them with computer algorithms.Computing is done with SAS. There are lectures devoted to SAS, giving tutorials from the ground up, and progressing with more detailed sessions that implement the techniques in each chapter.

PUBLIC Master level

PREREQUISITES S1-[MST]

DURATION 42 hours

DIVISION MAL-M1 – SAS and Datamining
MAL-M2 – Advances technics in machine learning

ECTS 5

SUGGESTED READINGS – James, G., Witten, D., Hastie, T., Tibshirani, R., *An Introduction to Statistical Learning, with Applications in R*, Springer, 2013.

COURSE TAUGHT IN French - English

BASED Évry

[MAL-M1] UNSUPERVISED LEARNING

INSTRUCTOR Nistor Grozavu

MISSION AND CONTEXT Elective course

OBJECTIVES This course covers the skills required for a data miner to perform analysis for both pattern discovery (segmentation, association, and sequence analyses) and predictive modeling (decision tree, regression, neural network and other models). A practical knowlegde of data mining and business analytics with SAS is provided. This course is the practical and business counterpart of a "Machine Learning" course.

PUBLIC Master level

PREREQUISITES S1-[MST]

DURATION 21 hours

ORGANIZATION Pratical work: 12 sessions

CONTENT Learn how to (with SAS – SAS Enterprise Guide & Miner):
1. define a "data mining project" and explore data graphically;
2. modify data for better analysis results;
3. build and understand predictive models such as decision trees, regression models and others modeling tools;
4. compare and explain complex models;
5. generate and use score code;
6. apply association and sequence discovery to transaction data;
7. use other modeling tools such as rule induction, gradient boosting, PLS regression and support vector machines.

EVALUATION (SESSION 1) Project and Continuous assessment

EVALUATION (SESSION 2) Multiple Choice Questions

SUGGESTED READINGS – Hastie, T., Tibshirani, R., Friedman, J, *The Elements of Statistical Learning: Data Mining, Inference and Prediction*, Springer, 2009;
– Kleinman, K., Horton, N. J., *SAS and R: Data Management, Statistical Analysis and Graphics*, CRC Press, 2014.

COURSE TAUGHT IN French - English

BASED Évry

[MAL-M2] SUPERVISED LEARNING

INSTRUCTOR Mehdi Chouiten

MISSION AND CONTEXT Elective course

OBJECTIVES The course will provide an introduction to Machine Learning and its core models and algorithms. The aim of the course is to provide students of statistics with detailed knowledge of how Machine Learning methods work and how statistical models can be brought to bear on computer systems analyzing large data sets, but also to let computers perform tasks that traditional methods of computer science are unable to address.

PUBLIC Master level

PREREQUISITES S1-[MPR], S1-[MST]

DURATION 21 hours

ORGANIZATION Course: 6 sessions - Pratical Work: 6 sessions

CONTENT
– Estimation and Prediction for ML;
– Ensemble methods for prediction (classification and regression): trees, boosting, bagging, random forest, aggregation;
–Tools for Data Science and ML in production: R, Python, Data Science Studio.

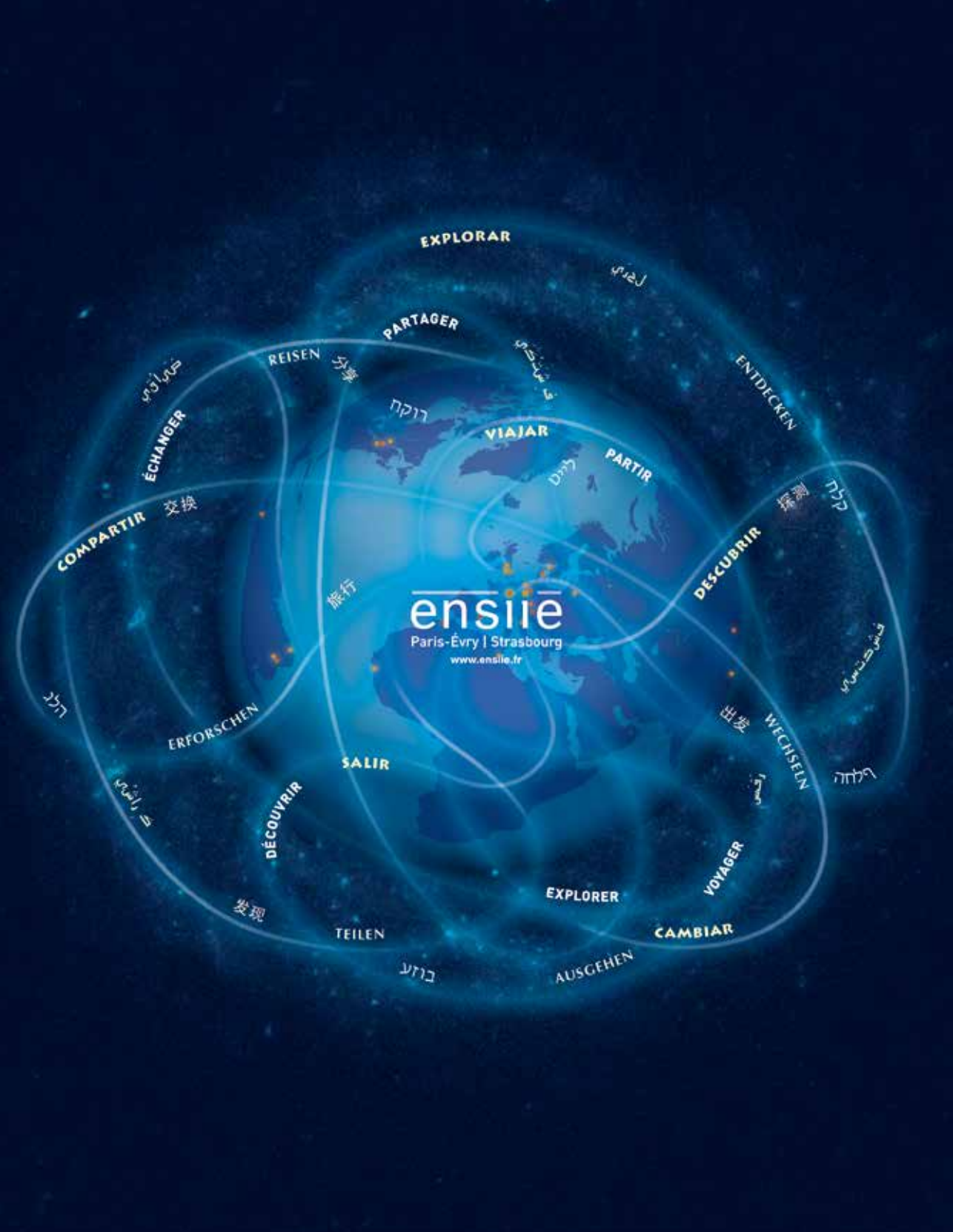
EVALUATION (SESSION 1) Pratical Work and project

EVALUATION (SESSION 2) Written Exam

SUGGESTED READINGS
– Mitchell, T., *Machine Learning*, McGraw-Hill Press, 1997;
– Bishop, C. M., *Pattern Recognition & Machine Learning*, Springer, 2006;
– Barber, D., *Bayesian Reasoning and Machine Learning*, Cambridge University Press, 2012.

COURSE TAUGHT IN French - English

BASED Évry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