PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

HARMONIZATION MASTER TRAINING OFFER ACADEMIC

Establishment	Faculty / Institute	Department
Mohamed Khider University- Biskra	Faculty of Exact Sciences and Sciences of Nature and Life	Mathematics

Field: Mathematics and Computer Science
Sector: Mathematics
Specialty: Applied Mathematics

Academic year: 2016 - 2017

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

مواءمة

عرض تكوين ماستر

أكاديمي

المؤسسة	الكلية/ المعهد	القسم
جامعة محمد خيضر بسكرة	كلية العلوم الدقيقة و علوم الطبيعة و الحياة	الرياضيات

الميدان : رياضيات و الاعلام الالي

الشعبة : رياضيات

التخصص : رياضيات تطبيقية

السنة الجامعية: 2016- 2017

SUMMARY

I – Master’s identity form
(All fields must be completed)

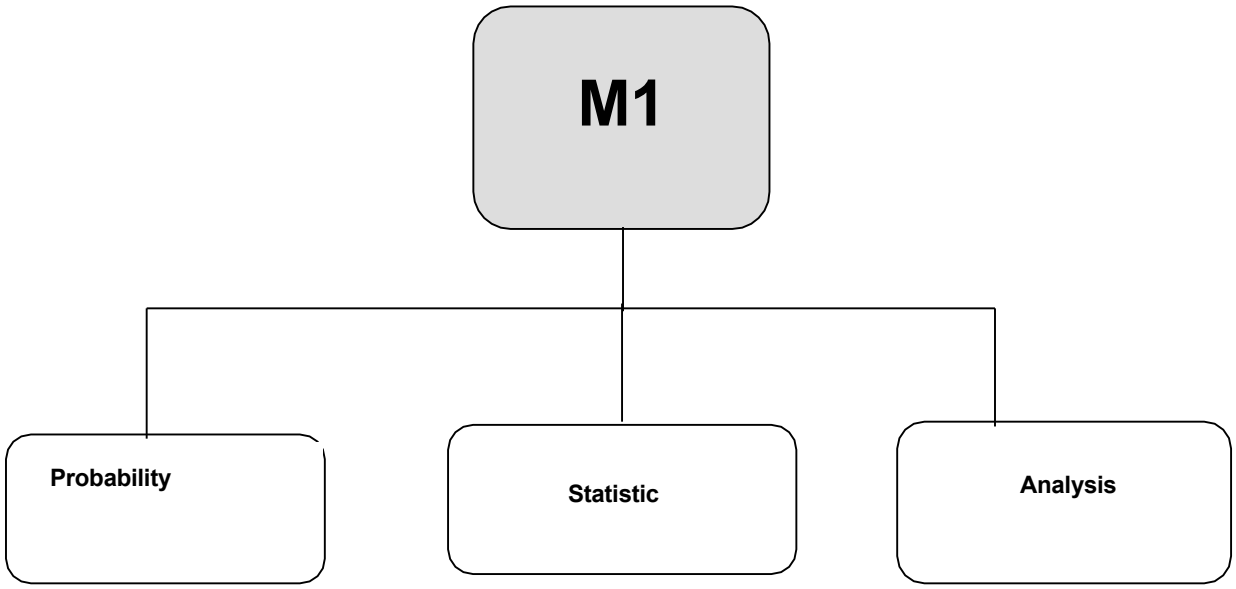
* = Present the conventions in the appendix to the training

3 – Context and objectives of the training

A – Access conditions

(indicate the license specialties, which can give access to the Master's degree).
Bachelor's degree in Mathematics or an equivalent qualification. The first year M1 is open to students who have obtained a Bachelor of Mathematics. In the second year M2, admitted students can choose one of the following courses:

Probability - Statistics - Analysis.



B - Training objectives

(targeted skills, pedagogical knowledge acquired at the end of the training - maximum 20 lines).
The Master's degree in mathematics entitled: "Applied Mathematics", offers students holding a bachelor's degree in mathematics (L.M.D) or an equivalent qualification basic training in probability - statistics and analysis and opportunities for specialization in various areas close to applications. The main themes of this training are the theory of stochastic processes, optimal control of random systems, process statistics, numerical analysis, approximation theory, wavelets... On these themes, the training benefits from a good potential for supervising dissertations or theses. This training naturally complements the graduate training in mathematics provided by our department for several years. In addition, this will meet the expectations of our students and in particular, the best of them who plan to pursue in-depth studies in one of the themes offered by this post-graduation.

C – Targeted professional profiles and skills

(in terms of professional integration - maximum 20 lines):

This Master's degree in Applied Mathematics aims to train – researchers in applied mathematics likely to have a career in higher education or within a research organization or to participate in high-tech industry programs. – high-level mathematical engineers intended to work in industrial design offices or in scientific computing service companies, mastering the aspects of modern scientific computing (from modeling and mathematical analysis to digital resolution and the actual implementation on computer) or probabilities and statistics. – For a substantial fraction of students, the natural extension of the Master's degree consists of continuing this introduction to research with a doctoral thesis.

D- Regional and national employability potential of graduates

• **Sectors of activity:**

Education, higher education, statistics office, banks, insurance, industry, services, etc.

• **Professions:**

Teacher-Researcher, statistician, actuary…

E – Gateways to other specialties:

The program for the first two semesters S1 and S2 is common, the modules of which cover a large part of the basic mathematics for several specialties (theoretical and applied statistics, stochastic processes and applications, analysis and random models, etc.).

F – Training monitoring indicators

Establish a commission bringing together the teachers involved in the course, which will be responsible for monitoring the training in accordance with the program and in a second stage propose possible changes to be made to the subject programs.

G – Supervision capacity

(give the number of students that it is possible to support).

The mathematics department can support up to 120 students.

4 – Human resources available

A: Teachers from the establishment working in the specialty:

Name, first name	Graduation diploma + Specialty Diploma	Post graduation + Specialty	Grade	Type of intervention *	Registration
Mezerdi Brahim	SSDProba-Stat	PHD	Prof	Courses+Td+superviisor	
Necir Abdelhakim	SSD Proba-Stat	PHD	Prof	Courses+Td+superviisor	
Meraghni Djamel	SSD Proba-Stat	Doctorate in Science	Prof	Courses+Td+superviisor	
Labed Boubakeur	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Khelil Naceur	SSD Analysis	Doctorate in Science	MC A	Courses+Td+superviisor	
Mokhtari Zouhir	SSD Analysis	Doctorate in Science	MC A	Courses+Td+superviisor	
Zerroug Abdelhamid	SSD Analysis	Doctorate in Science	MC A	Courses+Td+superviisor	
Bellagoune Abdelghani	SSD Analysis	Doctorate in Science	MC A	Courses+Td+superviisor	
Chighoub Farid	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Yahia Djabrane	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Brahimi Brahim	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Hafayed Mokhtar	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Mansouri Bardeddine	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Khelfallah Nabil	SSD Analysis	Doctorate in Science	MC A	Courses+Td+superviisor	
Gherbal Boulakharas	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Benatia Fateh	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Chala Adel	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Sayah Abdellah	SSD Proba-Stat	Doctorate in Science	MC A	Courses+Td+superviisor	
Berbiche Mohamed	SSD Analysis	Doctorate in Science	MC A	Courses+Td+superviisor	
Chemchem Madani	SSD Analysis	Doctorate in Science	MC B	Courses+Td+superviisor	
Touba Sonia	SSD Proba-Stat	Doctorate in Science	MC B	Courses+Td+superviisor	
Rajah Faouzia	SSD Proba-Stat	Doctorate in Science	MC B	Courses+Td+superviisor	
Dakhia Ghania	SSD Analysis	Doctorate in Science	MC B	Courses+Td+superviisor	
Tamer Lazhar	SSD Proba-Stat	Doctorate in Science	MC B	Courses+Td+superviisor	
Agram Nacira	Master-AM	Doctorat	MCB	Courses+Td+superviisor	

Laadjel Baya	**SSD Analysis**	**Doctorat en Sciences**	**MC B**	**Courses+Td+superviisor**	
Menacer Tidjani	**SSD Analysis**	**Doctorat en Sciences**	**MC B**	**Courses+Td+superviisor**	
BoughraraSaliha	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Adouane Saida	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Cherfaoui Miloud	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Guidad Daraji	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Aba Fadila	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Bouziane Nadjette	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Souker Abdessalem	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Berkane Hassiba	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Roubi Afafe	**ING Stat**	**Magister**	**MAA**	**superviisor**	
Chine Amel	**ING Stat**	**Magister**	**MAA**	**superviisor**	
Ghoul Abdelhak	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Belmir Imane	**ING Stat**	**Magister**	**MAA**	**superviisor**	
Ghoudjmis Fatiha	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Soltani Sihem	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Benameur sana	**ING Stat**	**Magister**	**MAA**	**superviisor**	
Tabarha Warda	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Labed Saloua	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Djaber Ibtissem	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Diabi Samra	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Senouci Assia	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Brahim Rezghi	**SSD Analysis**	**Magister**	**MAA**	**superviisor**	
Zeghdoudi Khadem	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Zouzou Akila	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Abba Abdelmadjid	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	
Benbrika Ghouzlane	**ING Stat**	**Magister**	**MAA**	**superviisor**	
Kourichi Fatiha	**SSD Proba-Stat**	**Magister**	**MAA**	**superviisor**	

* = Courses, tutorials, practical work, internship supervision, dissertation supervision, other (to be specified)

B: External supervision:

Home establishment:

Name, first name	Graduation diploma + Specialty Diploma	Post graduation + Specialty	Grade	Type of intervention *	Registration

Home establishment:

Name, first name	Graduation diploma + Specialty Diploma	Post graduation + Specialty	Grade	Type of intervention *	Registration

Home establishment:

Name, first name	Graduation diploma + Specialty Diploma	Post graduation + Specialty	Grade	Type of intervention *	Registration

* = Courses, tutorials, practical work, internship supervision, dissertation supervision, other (to be specified)

5 – Specific material resources available

A- Educational Laboratories and Equipment:

Sheet of existing educational equipment for the practical work of the planned training (1 sheet per laboratory)

Laboratory title: Applied Mathematics.

N°	Equipment title	Number	observations
1	Microcomputer	32	
2	Data-show	02	
3	Printer	03	
4	Photocopy	01	

B- Internship sites and in-company training:

Location of the internship	Number of students	Duration of the internship

C- Master's support research laboratory(ies):

Head of the laboratory; Prof. NECIR Abdelhakim
No. Laboratory approval 2001
Date : **Opinion of the laboratory head:**

D- Master's support research project(s):

Title of the research project	Project code	Project start date	Project end date

E- Personal work spaces and ICT:

- University Central Library
- Faculty library
- Laboratory library
- Faculty internet room
- Educational rooms

II – Semester organization sheet for teaching (Please present the sheets for the 4 semesters)

1- Semester 1:

Teaching Unit	VHS	V.H Weekly				Coeff	Credits	Evaluation Mode	
	14-16	C	TD	TP	Others			Continuous	Exam
Fundamental EU									
UEF1									
Deep Probability	45h00	1h30	1h30			3	05	X	X
Laws of probability	45h00	1h30	1h30			3	04	X	X
UEF2									
Statistical tests	45h00	1h30	1h30			3	05	X	X
Data analysis	45h00	1h30	1h30			3	04	X	X
UE methodology									
UEM1									
Banach and Hilbert spaces	45h00	1h30	1h30			3	05	X	X
Distributions, PDE	45h00	1h30	1h30			3	04	X	X
UE Discovery									
UED1									
Scientific English 1	22h30	1h30				2	03		X
Total Semester 1	292h30	10h30	9h0			20	30		

2. **Semester 2:**

Teaching Unit	VHS	V.H Weekly				Coeff	Credits	Evaluation Mode	
	14-16	C	TD	TP	Others			Conti	Exam
Fundamental EU									
UEF3									
Martingale Theory	45h00	1h30	1h30			3	05	X	X
Stochastic Processes	45h00	1h30	1h30			3	04	X	X
UEF4									
Time series	45h00	1h30	1h30			3	05	X	X
Linear models	45h00	1h30	1h30			3	04	X	X
UE methodology									
UEM2									
Operator theory	45h00	1h30	1h30			3	05	X	X
Numerical methods	45h00	1h30	1h30			3	04	X	X
UE Discovery									
UED2									
Scientific English 2	22h30	1h30				2	03		X
Total Semester 2	292h30	10h30	9h0			20	30		

3. **Semester 3**:

• Students admitted to the second year M2 can choose one of the following courses:
Probability - Statistics - Analysis.

• The Methodological (UEM3) and Transversal (UET1) teaching units are common for the three courses.
The fundamental units (UEF5) of each course are independent.

a- Path: Probabilities

Teaching Unit	VHS	V.H Weekly				Coeff	Credits	Evaluation Mode	
	14-16	C	TD	TP	Others			Conti	Exam
Fundamental EU									
UEF5									
Brownian motion and stochastic calculus	67h30	3h00	1h30			6	9	X	X
General theory of stochastic processes	67h30	3h00	1h30			6	9	X	X
UE methodology									
UEM3									
Convex analysis	45h00	1h30	1h30			3	5	X	X
Simulation and numerical methods	45h00	1h30		1h30		3	4	X	X
UE Transversal									
UET1									
Research methodology	22h30	1h30				2	3		X
Total Semester 3	247h30	10h30	4h30	1h30		20	30		

b- Parcours : Statistique

Teaching Unit	VHS	V.H Weekly				Coeff	Credits	Evaluation Mode	
	14-16	C	TD	TP	Others			Cont	Exam
UE Fundamental									
UEF5									
Empirical processes and order statistics	67h30	3h00	1h30			6	9	X	X
Non-parametric statistics	67h30	3h00	1h30			6	9	X	X
UE methodology									
UEM3									
Convex analysis	45h00	1h30	1h30			3	5	X	X
Simulation and numerical methods	45h00	1h30		1h30		3	4	X	X
UE Transversal									
UET1									
Research methodology	22h30	1h30				2	3		X
Total Semester 3	247h30	10h30	4h30	1h30		20	30		

c-Parcours : Analyse

Teaching Unit	VHS	V.H Weekly				Coeff	Credits	Evaluation Mode	
	14-16	C	TD	TP	Others			Contin	Exam
UE Fundamental									
UEF5									
Fourier and wavelet analysis	67h30	3h00	1h30			6	9	X	X
Approximation theory and applications	67h30	3h00	1h30			6	9	X	X
UE methodology									
UEM3									
Convex analysis	45h00	1h30	1h30			3	5	X	X
Simulation and numerical methods	45h00	1h30		1h30		3	4	X	X
UE Transversal									
UET1									
Research methodology	22h30	1h30				2	3		X
Total Semester 3	247h30	10h30	4h30	1h30		20	30		

4- **Semester 4:**

Field: Mathematics and computer science

Branch: Mathematics

Specialty: Applied Mathematics

Internship in a company culminating in a dissertation and a defense.

	VHS	Coeff	Credits
Personal work	**225h00**		
Internship in company			
Seminars			
Dissertation		**18**	**30**
Total Semester 4	**225h00**	**18**	**30**

5-**Overall summary of the training:**

(indicate the separate global VH in progress, TD, for the 04 semesters of teaching, for the different types of EU)

VH \ UE	UEF	UEM	UED	UET	Total
Cours	**270h**	**135h**	**45h**	**22h30**	**472h30**
TD	**270h**	**112h30**			**382h30**
TP		**22h30**			**22h30**
Personal work	**225h00**				**225h00**
Others (precis)					
Total	**765h**	**270h**	**45h**	**22h30**	**1102h30**
Credits	**84**	**27**	**6**	**3**	**120**
% in credits for every UE	**70%**	**22.5%**	**5%**	**2.5%**	**100%**

III - Detailed program by subject (Detailed sheet per subject)

Title of the Master: Applied Mathematics

Semester: S1
EU title: UEF1
Subject title: Advanced probability
Credits: 5
Coefficients: 3

Teaching objectives

The aim of the course is to review the concepts seen in the license on random variables and to deepen them and complete them by the study of new concepts such as conditional expectation.

Recommended prior knowledge

Measurement and integration, probability of the mathematics license

Content of the material:

• Conditional probability.
Bayes' theorems. Conditional random variables, conditional density. Conditional hope. Case of the multinomial law.
• Lp spaces, duality, equi-integrability and equi-continuity. Some additional information on convergence theorems.
• Conditional expectation (probability) given a tribe. Conditional expectation as an orthogonal projection operator. Regular version of a conditional probability.
• Transformations preserving the measure. Stationary suites. Ergodic theorem. Law of large numbers.

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

P. Barbe, M. Ledoux, Probabilité, Belin, Paris, 1998.
P. Jaffard, Méthode de statistique et du calcul des probabilités, Masson, paris, 1996.
K. Vo Khac, Théorie de probabilités, Ellipses, paris, 1984.
J. Neveu, Bases Mathématiques du calcul des probabilités, Masson, 1964.
D. Revuz Probabilités et statistiques, (collection Méthodes) Edition, Hermann ,1997 .
R. Durrett Probability : Theory and examples (2nd ed.) Edition : Duxbury Press 1991

Title of the Master: Applied Mathematics

EU title: UEF1

Subject title: Laws of probability

Credits: 4

Coefficients: 3

Teaching objectives

To study in detail some discrete and continuous probability laws

Recommended prior knowledge

Mathematics license probabilities

Content of the material:

1) Discrete laws:

The uniform law, the hypergeometric law, the binomial law, Poisson's law, the geometric law, etc.

2) Continuous laws:

The uniform law, the exponential law, the normal law, the gamma law, the log-gamma law, the chi-square laws, the Fischer Snedecor laws, the student laws

3) Mixtures of distributions:

Mixtures of discrete distributions, mixture of density distributions, intermediate case

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

P. Barbe, M. Ledoux, Probabilité, Belin, Paris, 1998.

P. Jaffard, Méthode de statistique et du calcul des probabilités, Masson, paris, 1996.

K. Vo Khac, Théorie de probabilités, Ellipses, paris, 1984.

J. Neveu, Bases Mathématiques du calcul des probabilités, Masson, 1964.

D. Revuz Probabilités et statistiques, (collection Méthodes) Edition, Hermann ,1997 .

R. Durrett Probability : Theory and examples (2nd ed.) Edition : Duxbury Press 1991

Title of the Master: Applied Mathematics

EU title: UEF2
Subject title: Statistical tests
Credits: 5
Coefficients: 3

Teaching objectives

In statistics, a hypothesis test is a process consisting of rejecting or not rejecting (rarely accepting) a statistical hypothesis, called the null hypothesis, based on a set of data (sample).
This is a continuation of the study of inferential statistics in the third year of the Mathematics Degree.

Recommended prior knowledge

Probability and inferential statistics.

Content of the material:

-Statistical inference and statistical decision - Specification of the decision problem - Randomization, choice of experiment - Optimal procedures - Bayes and minimax procedures - Maximum likelihood - Complete classes - Complete statistics - Neyman-Person fundamental lemma - Distributions with a monotonic likelihood ratio - Comparisons of experiments - Confidence bounds - Generalization of the fundamental Lemma. - Bilateral hypotheses - Test of the mean and variance of the normal law - Invariance - Linear hypotheses - Multivariate linear hypotheses.

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

Title of the Master: Applied Mathematics

Semester: S1
EU title: UEF2
Subject title: Data analysis
Credits: 4
Coefficients: 3

Teaching objectives:

Recommended prior knowledge

(brief description of the knowledge required to be able to follow this course – Maximum 2 lines).

Content of the material:

1. Regression methods
2. Analysis of variance
3. Generalized linear models
4. Specification of models
5. Hypothesis testing
6. "Diagnostics" validation

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

- P. Dagnelie, *Statistique théorique et appliquée*, t. 1 : *Statistique descriptive et base de l'inférence statistique*, Paris et Bruxelles, De Boeck et Larcier, 2007.
- P. Dagnelie, *Statistique théorique et appliquée*, t. 2 : *Inférence statistique à une et à deux dimensions*, Paris et Bruxelles, De Boeck et Larcier, 2006.
- G. Millot, *Comprendre et réaliser les tests statistiques à l'aide de R 3ème édition*, De Boeck, Louvain-la-Neuve, 2014.
- J.-J. Droesbecke, *Éléments de statistique*, Ellipses, Paris, 2001.
- B. Escofier et J. Pages, *Initiation aux traitements statistiques : Méthodes, méthodologie*, Rennes, Presses universitaires de Rennes, 1997.
- Falissard et Monga, *Statistique : concepts et méthodes*, Masson, Paris, 1993.
- H. Rouanet, J.-M. Bernard et B. Le Roux, *Statistique en sciences humaines : analyse inductive des données*, Dunod, Paris, 1990.
- G. Saporta, *Probabilité, analyse des données et statistique*, Technip, Paris, 1990.
- R. Veysseyre, *Statistique et probabilité pour l'ingénieur*, Dunod, Paris, 2002.

Title of the Master: Applied Mathematics

Semester: S1
EU title: UEM1
Subject title: Banach and Hilbert spaces
Credits: 5
Coefficients: 3

Teaching objectives

The goal of this course is to complete students' knowledge of functional analysis and to introduce them to some useful tools for partial differential equations and analysis.

Recommended prior knowledge

Topology, functional analysis, measure, and license integration

Content of the material:

1. Complements on Hilbert spaces:

Hilbertian bases, reproducing kernels, weak convergences and weak topology

2. Complements on Banach spaces:

Baire, Banach –Steinhaus theorems, open application. Duality, weak topologies. Geometry of Banach spaces

3. Analysis of Lp spaces:

Some properties, interpolation, applications…

4. Introduction to wavelets:

Construction, algorithms, basic examples. Characterizations of functional spaces. Applications

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

R. A. Adams, Sobolev Spaces, Academic Press, 1975.
H. Brezis, Analyse fonctionnelle, Masson, 1983.
F. Hirsch, G. Lacombe, Eléments d'analyse fonctionnelle, Masson, 1998.
Y. Meyer, Ondelettes et opérateurs, tome 1, Hermann, 1990.
Y. Meyer, Ondelettes et algorithmes concurrents, Hermann, 1993
W. Rudin, Analyse fonctionnelle, Ediscience.
K. Yosida, Functional Analysis, Springer Verlag, 1995

Title of the Master: Applied Mathematics

Semester: S1
EU title: UEM1
Subject title: Distributions and EDP
Credits: 4
Coefficients: 3

Teaching objectives

Presentation of the distribution formalism and resolution of some linear PDEs

Recommended prior knowledge

Topology and functional analysis done in mathematics degree

Content of the material:

Distribution space. Operations on distributions: derivation. Convolution and Fourier transformation. Fourier analysis in S'(R") Sobolev spaces Study of some classic PDEs (transport and diffusion phenomenon). Link with Brownian movement and financial market models.

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

R. A. Adams, Sobolev Spaces, Academic Press, 1975.
H. Brezis, Analyse fonctionnelle, Masson, 1983.
E. Di Benedetto, partial differential equations, Birkhauser, 1995
L. C. Evans, partial differential equations, AMS, Providence, 1998
F. Hirsch, G. Lacombe, Eléments d'analyse fonctionnelle, Masson, 1998.

Title of the Master: Applied Mathematics

Semester: S1
EU title: UED1
Subject title: Scientific English 1
Credits: 3
Coefficients: 2

Teaching objectives

The objectives are to give students the ability to express themselves clearly and simply by Improving students' skills in scientific communication (oral and written)

Recommended prior knowledge

(brief description of the knowledge required to be able to follow this course – Maximum 2 lines).

Content of the material:

Scientific presentation (use of slides, presentation materials / description of experiments, results and commentary / acquisition of register and structures specific to the scientific presentation).

• Pronunciation, phonetics.

• Interview simulation (recruitment / evaluation / motivation / contradictory debate), preparation for mobility in an English-speaking country.

• Writing summaries

• Acquisition of vocabulary relating to the general scientific field (description and commentary of experiments, graphs, trends) and logical argumentation (comparisons, consequences, hypotheses).

• Writing cover letters, CVs, letters to an editor for publication.

• Analysis of publications and scientific articles.

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

Title of the Master: Applied Mathematics

Semester: S2
EU title: UEF3
Subject title: Martingale Theory
Credits: 5
Coefficients: 3

Teaching objectives

The objective is to complete students' knowledge of martingale theory and their applications.

Recommended prior knowledge

Semester 1 probability calculation.

Content of the material:

Discrete time martingales.
Downtime and sampling theorems.
Doob inequality and convergence theorems.
Reversed Martingales.
Zero-one law, law of large numbers and three series theorems.
Applications.

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.)

W. Feller, An introduction to probability theory and its application, Tome2, Wiley, 1966.

J. Neveu, Bases Mathématiques du calcul des probabilités, Masson, 1964.

J. Neveu, Martingales à temps discret, Masson, 1972.

D Williams Probability with martingales Edition, University Press, Cambridge, 1991.

Title of the Master: Applied Mathematics

Semester: S3
EU title: UEF3
Subject title: Stochastic Processes
Credits: 5
Coefficients: 4

Teaching objectives

The objective is to complete students' knowledge of the theory of Stochastic Processes and their applications.

Recommended prior knowledge

(brief description of the knowledge required to be able to follow this course – Maximum 2 lines).
Introduction to S1 processes and probabilities

Content of the material:

Concept of process
Types of process
Mathematical approach to stochastic processes
Trajectory of a stochastic process
Probability measure induced by a stochastic process
Indistinguishable stochastic processes
Measurability of a stochastic process

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

Sabin Lessard: *Processus stochastiques - cours et exercices corrigés*. Ellipses, 2014. Jean-Claude Laleuf: *Processus et intégrales stochastiques*. Ellipses, 2014.
Valérie Girardin, Nikolaos Limnios: *Probabilités - Processus stochastiques et applications*. Vuibert, 2014.
Yvon Mori: *Signaux aléatoires et processus stochastiques*. Hermes/Lavoisier, 2014.
Jacques Franchi: *Processus aléatoires à temps discret - Cours, exercices et problèmes corrigés*. Ellipses, 2013.
F. Comets et T. Meyre, *Calcul stochastique et modèles de diffusions*, éditions Dunod, 2006

Title of the Master: Applied Mathematics

Semester: S3
EU title: UEF4
Subject title: Time series
Credits: 5
Coefficients: 3

Teaching objectives

- Statistical modeling of temporal data - Parametric forecasts

Recommended prior knowledge

Inferential statistics, data analysis, testing and basic probabilities

Content of the material:

1- Temporal Series: Definitions and examples
2- Exponential smoothing
3- Stationary Models
4- ARMA models
5- Forecasts

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

- Anderson, T. W., (1971). *The Statistical Analysis of Time Series*. Wiley, New York.
- Brillinger, D. R. (1981). Time Series, Data Analysis and Theory. Rinehart & Winston, New York.
- Brockwell, P. J. and Davis, R. A., (1991), *Time Series: Theory and Methods*. Springer Verlag, New York.
- Box, G. E. P., Jenkins, G. M., and Reinsel, G. C., (1994). *Time Series Analysis, Forecasting and Control*. Prentice Hall, Englewood Cliffs, New Jersey, Third Edition.

Priestley, M. B. (1981), *Spectral Analysis and Time Series*, Volume 1, Acad. Press, New-York

Title of the Master: Applied Mathematics

Semester: S2
EU title: UEF4
Subject title: Linear models
Credits: 5
Coefficients: 5

Teaching objectives

At the end of this course, the student will be familiar with the main linear models commonly used in statistics and will be able to analyze real data using software. The course focuses mainly on the methodology, interpretation and mechanisms behind linear models and less on the theoretical and mathematical aspects.

Recommended prior knowledge

Statistics done in mathematics degree

Content of the material:

1. Foreplay
2. Principal Component Analysis (PCA):
3. Factor Correspondence Analysis (CFA)
4. Multiple Correspondence Factor Analysis (MFMA)

Canonical Analysis

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

Arnold, S.F. (1981), The theory of linear models and multivariate analysis. Wiley, New York. Neter, J., Kutner, M.H., Nachtsheim, C.J. et Wasserman, W. (1996), Applied linear statistical models. McGraw-Hill, Boston

Title of the Master: Applied Mathematics

Semester: S2
EU title: EMU2
Subject title: Operator theory
Credits: 5
Coefficients: 3

Teaching objectives

(Describe what skills the student is supposed to have acquired after passing this subject – maximum 3 lines).

Recommended prior knowledge

Banach and Hilbert spaces module of the first semester

Content of the material:

Linear operators.
Linear shapes.
Duality.
Compact operators and spectral decomposition.
Bounded operators.
Polar decomposition.
Invertible operators: resolvent and spectrum (discrete, essential).
Self-adjoint operators:
Spectral measurements and functional calculus.
Algebra and representation theory.
Groups (semi-groups) with one parameter. Stone's theorem.
Unbounded operators and quadratic forms.
Operators closed. Symmetric and self-adjoint operators.
Spectral characterization Perturbation theory, relatively bounded disturbances, relatively compact (finite rank) disturbances.

Evaluation method

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

H. Brezis, Analyse fonctionnelle, Masson, 1983.
F. Hirsch, G. Lacombe, Eléments d'analyse fonctionnelle, Masson, 1998.
W. Rudin, Analyse fonctionnelle, Ediscience.
K. Yosida, Functional Analysis, Springer Verlag, 1995

Title of the Master: Applied Mathematics

Semester: S2
EU title: EMU2
Subject title: Numerical methods
Credits: 4
Coefficients: 3

Teaching objectives

Learn numerical methods for solving analysis problems and partial differential equations; learn the technique of demonstrating convergence of numerical methods for model problems and "extrapolate" these methods onto complex real problems

Recommended prior knowledge

Numerical analysis methods studied in mathematics and linear partial differential equations

Content of the material:

- Multi-dimensional quadratures. Monte Carlo method.
- Approximations of partial differential equations using finite difference schemes.
- Stability and convergence of patterns.
- Domain decomposition, fictitious domain method.
- Finite element method: convergence theorem and applications.

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

- T. Lascaux, Méthodes numériques pou l'ingénieur.
- N Bakhvalov, Méthodes numériques, Edition Mir, Moscou, 1976.
- A. Samarskii, Schémas aux différences finies, Mir

A. samarskii, E. Nikilaiev, Méthodes de résolution des équations de mailles, Moscou, Edition Mir, 1981

Title of the Master: Applied Mathematics

Semester: S2
EU title: UED2
Subject title: Scientific English 2
Credits: 3
Coefficients: 2

Teaching objectives

The aim of this unit is to help students master English in the context of research and teaching in mathematics and applications of mathematics. Develop their ability to understand, write and present mathematics in English, and oral comprehension during less formal exchanges (questions during a conference, etc.)

Recommended prior knowledge

Scientific English 1 of the first semester

Content of the material:

Reading scientific articles. Learning to write. Oral presentation training

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

Title of the Master: Applied Mathematics
Semester: S3 - Course: Probabilities
EU title: UEF5
Title of the subject: Brownian motion and stochastic calculation
Credits: 9
Coefficients: 6

Teaching objectives

The aim of this course is to present the usual continuous-time stochastic processes and particularly Brownian motion and the theory of stochastic integration. These notions will allow students to deepen their knowledge in directions such as: stochastic control, etc.

Recommended prior knowledge

Students are expected to have completed a basic stochastic calculus course

Content of the material:

• Elements of the general theory of continuous time processes. Predictable, optional processes, filtrations. Continuous time martingales. Definition and some properties of Markov processes, infinitesimal generator and Dynkin formula.
• Brownian motion, construction and properties of trajectories. Approximation by random walks.
• Stochastic integral with respect to Brownian motion, Ito formula.
• Stochastic differential equations with Lipschitzian coefficients. Existence, uniqueness. Feyman-Kac formula and application to elliptical and parabolic PDEs.
• Applications to stochastic control and financial mathematics: stochastic pontriagin principle and HJB equation. Black-Scholes formula

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

- N. Bouleau, Processus stochastiques et applications, Hermann, 1988.
- I. Karatzas, S. Shreve, Brownian motion and Stochastic calculus, Springer 1987.
- D. Revuz, M. Yor, Continous martingales and Brownian motion, Springer 1991.
- B. Oksendal, Stochastic differential equations, Springer 1992..

M. Yong, X.Y Zhou, Stochastic controls, Hamiltonian systems and HJB equations , Springer, 1999

Title of the Master: Applied Mathematics
Semester: S3 - Course: Probabilities
EU title: UEF5
Subject title: General theory of stochastic processes
Credits: 9
Coefficients: 6

Teaching objectives

Deepen the study of stochastic processes: Martingales, semi-martingales, Poisson processes, point processes, Lévy processes.

Recommended prior knowledge

Calculation of probabilities, Convergence theorems in probabilities, Discrete-time Martingales of the first year of the master's degree

Content of the material:

• Stochastic processes: general definitions, predictable and optional tribes, classification of downtime.
• Martingale theory: Discrete case, continuous case, local martingales, predictable projections.
• Semi martingales: Oblique hook of semi martingales, Quadratic variations, right hook, orthogonality, Doob-Meyer decompositions, Girsanov theorem.
• Jump process: Stochastic intensity process, probability change, marked processes, Poisson measurement, point process, random measurements.
• Lévy process: stable and infinitely divisible random variables, Lévy process properties, Girsanov theorem, Pecherskii identity, Rogozin, subordinaters

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

J. Bertoin, Lévy processes, Cambridge University Press, 1996.
L. Breiman, Probability, Addison Wesley, Reading MA, 1968.
D. Revuz and M. Yor, Continuous martingales and Brownian Motion, Springer Verlag, Berlin, 1999.
K. Sato, Lévy processes and infinitely divisible distributions, Cambridge University Press, 1999.

Title of the Master: Applied Mathematics
Semester: S3 - Course: Statistics
EU title: UEF5
Subject title: Empirical processes and order statistics
Credits: 9
Coefficients: 6

Teaching objectives

Recommended prior knowledge
(brief description of the knowledge required to be able to follow this course – Maximum 2 lines).

Content of the material:
1. Basic theory of order statistics
2. Order statistics for specific distributions
3. Characterizations using order statistics
4. Empirical process

Evaluation method
Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

David, H. A., Nagaraja, H. N. (2003), *Order Statistics* (troisième édition). Wiley, New Jersey, p. 458.
Herbert Aron David, *Order Statistics*

Title of the Master: Applied Mathematics
Semester: S3 - Course: Statistics
EU title: UEF5
Subject title: Nonparametric statistics
Credits: 9
Coefficients: 6

Teaching objectives
(Describe what skills the student is supposed to have acquired after passing this subject – maximum 3 lines).

Recommended prior knowledge
(brief description of the knowledge required to be able to follow this course – Maximum 2 lines).

Content of the material:
1. Introduction
2. Nanparametric tests
3. Association tests
4. Non-parametric estimation
5. Asymptotic theory

Evaluation method:
Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

- Härdle et Linton, « Applied nonparametric methods », dans *Handbook of Econometrics*, 1994
- Emmanuel Flachaire et Ibrahim Ahamada, *Économétrie Non Paramétrique*,

Economica, 2008 Ahamada et Flachaire, *Non-Parametric Econometrics*, Oxford

University Press, 2010

Larry Wasserman, *All of Nonparametric Statistics*, Springer, 2007

Title of the Master: Applied Mathematics
Semester: S3 – Course: Analysis
EU title: UEF5
Subject title: Fourier analysis and wavelets
Credits: 9
Coefficients: 6

Teaching objectives

(Describe what skills the student is supposed to have acquired after passing this subject – maximum 3 lines).

Recommended prior knowledge

(brief description of the knowledge required to be able to follow this course – Maximum 2 lines).

Content of the material:

Fourier series.
Fourier transform (continuous and discrete).
Fast Fourier transform. Convolution.
Distributions. Continuous wavelet transform Multi-resolution analysis
Theoretical and algorithmic construction of wavelets
Decomposition and reconstruction algorithm Characterization of functional spaces

Evaluation method:

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

John J. O'Connor et Edmund F. Robertson, « Série de Fourier », dans MacTutor History of Mathematics archive, université de St Andrews (lire en ligne [archive]).
J. Fourier, Théorie analytique de la chaleur, voir le texte sur Gallica [archive], alinéa 235 p. 259 et alinéa 417 p.

Title of the Master: Applied Mathematics
Semester: S3 – Course: Analysis
EU title: UEF5
Subject title: Approximation theory and applications
Credits: 9
Coefficients: 6

Teaching objectives
(Describe what skills the student is supposed to have acquired after passing this subject – maximum 3 lines).

Recommended prior knowledge
(brief description of the knowledge required to be able to follow this course – Maximum 2 lines).

Content of the material:
Functional Spaces and the approximation problem.
Best Linear Approximation, Error Estimation Best Nonlinear
Approximation, Error Estimation
Algorithms Optimality of unconditional bases.
Selection of the best base, Applications: image compression, filtering, segmentation.
EDP models for image processing.

Evaluation method:
Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

Nick Trefethen (en), The definition of numerical analysis, paru dans SIAM News, novembre 1992. Numerische Mathematik : copies complètes numérisées en ligne des volumes 1-66, couvrant les années 1959 à 1994, d'un journal bien connu d'analyse numérique.
Eric Canon: Analyse numérique - Cours et exercices corrigés. Vuibert, 2012.

Title of the Master: Applied Mathematics

Semester: S3
EU title: UEM3
Subject title: Convex analysis
Credits: 5
Coefficients: 3

Teaching objectives:

This course is an introduction to some fundamental notions in convex analysis, in particular the notion of conjugate convex functions. Concrete applications could be studied (balance of a pile of sand,).

Recommended prior knowledge:

Topology, functional analysis, differential calculus

Content of the material:

1 Convex sets
2 Carathéodory's theorem, Helly's theorem
3 Topological properties of convexes
4 Convex functions
5 The Hahn-Banach theorem
6 Polarity
7 Legendre-Fenchel transform
8 Convexity and differentiability
9 The Krein-Milman theorem
10 Convex optimization
11 John's theorem
12 Spaces in duality and linear programming

Evaluation method

Final exam (50%) + continuous assessment (50%)

References

1. D. Azé, Eléments d'Analyse Convexe et Variationnelle ´ , Ellipses, 1998.
2. M. Bergounioux, Optimisation et Contrôle des Systèmes Linéaires, Dunod, 2001.
3. J.-B. Hiriart-Urruty, L'Optimisation, Collection Que sais-je, Presses Universitaires de France, 1996.
4. J.-B. Hiriart-Urruty & C. Lemaréchal, Convex Analysis and Minimization Algorithms, I and II, Springer-Verlag, 1993.
5. R.T. Rockafellar, Convex Analysis, Princeton University Press, Princeton, 1970.

M. Willem, Analyse Convexe et Optimisation (troisième ´édition), Editions ´ Ciaco, Bruxelles, 1989.

Title of the Master: Applied Mathematics

Semester: S3
EU title: UEM3
Subject title: Simulation and numerical methods
Credits: 4
Coefficients: 3

Teaching objectives

Teach students how to use some simulation software, mainly in statistics and programming.

Recommended prior knowledge

(brief description of the knowledge required to be able to follow this course – Maximum 2 lines).

Numerical Analysis, Topology,….

Content of the material:

1. Concepts of scientific programming
2. Differential equations and particle simulations
3. Representation of fields
4. Boundary problems
5. Time-dependent partial differential equations
6. Fluid dynamics
7. Optimization and nonlinear equations

Evaluation method

Final exam (50%) + continuous assessment (50%)

References (Books and handouts, websites, etc.).

Allaire G.,Analyse numérique et optimisation, Editions de l'Ecole Polytechnique, (2005). Danaila I., Joly P., Kaber S.M., Postel M., Introduction au calcul scientifique par la pratique, Dunod, Paris, (2005).

Dumas L., Modélisation à l'oral de l'agrégation, Calcul scientifique, Ellipses, Paris,(1999). Lucquin B., Pironneau O., Introduction au calcul scientifique, Masson, (1997).

Lucquin B., Equations aux dérivées partielles et leurs approximations, coll. Mathématiques à l'Université, Ellipses, Paris, (2004).

Rappaz J., Picasso M., Introduction à l'analyse numérique, Presses polytechniques et universitaires romandes, Lausanne, (1998).

Sainsaulieu L., Calcul scientifique. Cours et exercices corrigés, Dunod, Paris, (2000).

V- Agreements or conventions

NO

(If yes, transmit the agreements and/or conventions in the paper training file)