

Master en Enseignement Secondaire - Master en Enseignement Secondaire, Filière Mathématiques

Semestre 1

	CM (UE)	TD (UE)	ECTS
Specialisation - Mathematics 1			30
Computational Science 2 (optionnel)	28	28	4
Commutative Algebra (optionnel)	30	30	8
Riemannian Geometry (optionnel)	30	30	8
Partial Differential Equations I (optionnel)	30	30	8
Algorithmic Number Theory (optionnel)	30		4
Basics of Discrete Mathematics (optionnel)	30		4
Probabilistic Models in Finance (optionnel)	45		6
Student Project (optionnel)	0		4
Numerical Analysis (optionnel)		45	6
Probability (Stochastic Analysis) (optionnel)	30	15	6
Discrete-time stochastic processes (optionnel)	30	15	6
Complements to Graph Theory (optionnel)	1		1
Introduction to Graph Theory (optionnel)	30		3
Didactics - Mathematics 1 : In each of the 4 semesters of the Master in Secondary Education – Mathematics, the students are requested to choose 1 course in Didactics Professional Knowledge: research field school, educational system and policy, teaching and learning in the social context. Over the 4 semesters, all 3 fields must be covered. The students will be individually advised by the course director, who must validate their choice.			5
Applied Didactics I	30		2
Applied Didactics II	30		3
Internship in a secondary school I			0
General Competences I - Forschungsfeld Schule			5
Digitale Schule (1. Semester)	26		4

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	CM (UE)	TD (UE)	ECTS
Einführung in die Schulpädagogik	28		0
Workshop zur Vorbereitung des Schulpraktikums für Studierende im 1. Semester. (optionnel)	10		0

Semestre 2

	CM (UE)	TD (UE)	ECTS
Module 1			10
Probability (stochastic analysis) (optionnel)	45		5
Homological Algebra (optionnel)	45		5
Partial Differential Equations II (optionnel)	45		5
Graph theory (optionnel)	45		5
Module 2			5
Student Seminar (optionnel)	60		3
Algebraic Number Theory (optionnel)	30		4
Introduction to Continuous Time Models in Mathematical Finance (optionnel)	30		4
Numerical Analysis (optionnel)	30		4
An introduction to mathematical statistics (optionnel)	30		4
Reading course "complements to Homological Algebra" (optionnel)	15		1
Reading course "complements to Partial Differential Equation II" (optionnel)	15		1
Reading course "complements to Graph Theory" (optionnel)	15		1
Reading course "complements to Probability (stochastic analysis) (optionnel)	15		1
Module 3			5
Learning and teaching mathematics I	30		2

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	CM (UE)	TD (UE)	ECTS
Hands-on experiences with mathematical didactics I	30		3
Module 4 : General Professional Competence II			5
Mehrsprachigkeit im Sprach- und Fachunterricht	28		3
Didaktiken der Mehrsprachigkeit (optionnel)	24		5
Sprachvariation: Wann ist eine Sprache schwer? (optionnel)	24		5
Semester 2: Workshop zur Nachbereitung des orientierenden Schulpraktikums (de)	18		2

Semestre 3

	CM (UE)	TD (UE)	ECTS
Specialisation - Mathematics 3			30
Student Group Project (optionnel)	0		2
Arithmetic Geometry (optionnel)	45		6
Advanced Discretization Methods (optionnel)	30		5
Advanced Stochastic Modelling (optionnel)	30		5
Data Science (optionnel)	30		5
Numerical solution of partial differential equations and applications (optionnel)		30	5
Continuous-Time Stochastic Calculus and Interest Rate Models (optionnel)	30		5
Lie Algebras and Lie Groups (optionnel)	45		6
Gaussian processes and applications (optionnel)	30		5
Combinatorial Geometry (optionnel)	30	15	6
Didactics - Mathematics 3			5
Applied Didactics III	30		2
Applied Didactics IV	30		3

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	CM (UE)	TD (UE)	ECTS
Internship in secondary school II	0		0
General Competences III - Lehren und Lernen im sozialen Kontext			5
Teaching Children with Special Educational Needs (optionnel)	28		0
Einführung in die Pädagogische Psychologie (optionnel)	28		0
Digitale Schule (3. Semester) (optionnel)	28		0
Workshop zur Vor- und Nachbereitung des vertiefenden Schulpraktikums (optionnel)	15		0

Semestre 4

	CM (UE)	TD (UE)	ECTS
Module 4.1			5
Learning and teaching mathematics II	30		2
Hands-on experiences with mathematical didactics II	0		3
Module 4.2			20
Master Thesis	1		20
Module 4.3 : General Professional Competence IV - FHSE			3
Semester 4: Workshop zur Nachbereitung des orientierenden Schulpraktikums	10		2
Semester 4: Professionell Auftreten (optionnel)	30		1

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Semestre 1

Computational Science 2

Module: Specialisation - Mathematics 1 (Semestre 1)

ECTS: 4

Objectif: Computational Science is a field of applied computer science, that is, the application of computer science to solve problems across a range of disciplines. It combines computer simulation, scientific visualization, mathematical modeling, computer programming and data structures, networking, database design, symbolic computation, and high performance computing with various disciplines. This area offers exposure to many valuable ideas and techniques, including precision of numerical representation, error analysis, numerical techniques, parallel architectures and algorithms, modeling and simulation, information visualization, software engineering, and optimization.

Description:

1. Minimisation
 - 1.1. interior extremum +Newton
 - 1.1.1. Understand the principle of and be able to minimise a function with the NR method
 - 1.2. Conjugate gradient
 - 1.2.1. Understand the principle of and be able to minimise a function using nonlinear CG
 - 1.3. Genetic minimisation
 - 1.3.1. Understand the principle of and be able to minimise a function with GO
 - 1.4. Trust region
 - 1.4.1. Understand the principle of and be able to minimise a function with the trust region method
2. Numerical differentiation
 - 2.1. finite difference
 - 2.1.1. Understand the principle of and be able to find the derivatives of a function with finite differences
 - 2.2. adjoint methods
 - 2.2.1. Understand the principle of and be able to find the derivatives of a function with adjoint methods
3. Constrained minimisation
 - 3.1. Substitution
 - 3.1.1. Understand the principle of and be able to deal with constraints using substitution
 - 3.2. Penalty method
 - 3.2.1. Understand the principle of and be able to deal with constraints using penalties
 - 3.3. Lagrange multipliers
 - 3.3.1. Understand the principle of and be able to deal with constraints using Lagrange multipliers
 - 3.4. Augmented Lagrangian
 - 3.4.1. Understand the principle of and be able to deal with constraints using augm. Lagrangian method
 - 3.5. equality vs inequality constraint
 - 3.5.1. Understand the difference between equality and inequality constraints and be able to deal with both

Langue: Anglais

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Obligatoire:	Non
Evaluation:	<p>During the course (weeks 5 and 8), the student will receive two short exams, strongly based on the exercises in the lectures notes. The grades of these short exams will each be weighted with 20% for the final grade. At the end of the course (in the exam period), a final exam will take place, which will be weighted for 60%. The final grade is thus composed by 0.2 times the grade of the first short exam, by 0.2 times the grade of the second short exam, and by 0.6 times the grade of the final exam.</p> <p>Redoing students: Will receive two new short exams and a final exam during the summer semester (short exams in weeks 5 and 8, final exam in the exam period of the summer semester). The weight factors of these exams are the same as described above. (No lectures are provided during summer semester).</p>
Remarque:	<p>Notes and exercises will be provided. These notes and exercises are amongst others based on "Nocedal, J & Wright, S.J., Numerical optimisation. Springer Series in Operational Research and Financial Engineering, 2nd Edition, Springer Science+Business Media, LLC, New York, USA (2006). ISBN-10: 0-387-30303-0, ISBN-13: 978-0387-30303-1</p>
Professeur:	BEEX Lars

Commutative Algebra

Module:	Specialisation - Mathematics 1 (Semestre 1)
ECTS:	8
Objectif:	Learn the concepts of commutative algebra in relation to applications in algebraic number theory, algebraic geometry and other fields of mathematics.
Course learning outcomes:	The successful students possesses deepened and extended knowledge of the topics treated in Commutative Algebra.
Description:	<p>In number theory one is naturally led to study more general numbers than just the classical integers and, thus, to introduce the concept of integral elements in number fields. The rings of integers in number fields have certain very beautiful properties (such as the unique factorisation of ideals) which characterise them as Dedekind rings. Parallely, in geometry one studies affine varieties through their coordinate rings. It turns out that the coordinate ring of a curve is a Dedekind ring if and only if the curve is non-singular (e.g. has no self intersection).</p> <p>With this in mind, we shall work towards the concept and the characterisation of Dedekind rings. Along the way, we shall introduce and demonstrate through examples basic concepts of algebraic geometry and algebraic number theory. Moreover, we shall be naturally led to treat many concepts from commutative algebra.</p> <p>Depending on the previous knowledge of the audience, the lecture will cover all or parts of the following topics:</p> <ul style="list-style-type: none">- General concepts in the theory of commutative rings<ul style="list-style-type: none">+ rings, ideals and modules+ Noetherian rings+ tensor products+ localisation+ completion

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- + dimension
- Number rings
- + integral extensions
- + ideals and discriminants
- + Noether's normalisation theorem
- + Dedekind rings
- + unique ideal factorisation
- Plane Curves
- + affine space
- + coordinate rings and Zariski topology
- + Hilbert's Nullstellensatz
- + resultant and intersection of curves
- + morphisms of curves
- + singular points

Modalité d'enseignement:	Lecture course and problem sessions
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Mode: Continuous or Combined

For Master in Mathematics

The final mark is the arithmetic mean of a mark from continuous assessment (homework, supervised exercises, presentations) and a mark for the final exam.

For Master in Secondary Education - Mathematics

The final mark is the arithmetic mean of a mark from continuous assessment (homework, supervised exercises, presentations) and a mark for a didactical paper.

Remarque:	Lecture notes, exercise sheets (available on Moodle) Literature There are many books on commutative algebra, for example: <ul style="list-style-type: none">- E. Kunz, Introduction to Commutative Algebra and Algebraic Geometry.- Dino Lorenzini. An Invitation to Arithmetic Geometry, Graduate Studies in Mathematics, Volume 9, American Mathematical Society.- M. F. Atiyah, I. G. Macdonald. Introduction to Commutative Algebra, Addison-Wesley Publishing Company.
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Professeur:	WIESE Gabor, LA ROSA Alfio Fabio, KIEFER Ann
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Riemannian Geometry

Module:	Specialisation - Mathematics 1 (Semestre 1)
ECTS:	8
Objectif:	The objective is to allow the student to familiarize himself with a very active field of mathematics, with broad applications throughout science. Beyond this goal, special emphasizes will be put

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on the Mathematical Method, i.e., the optimal technique to learn and apply mathematics, in particular in order to solve real life problems using mathematical tools. This method is the most important of the objectives of any study program in mathematics.

Course learning outcomes:

On successful completion of the course, the student should be able to:

- Explain the main definitions and results of Differential and Riemannian Geometries
- Comment on new concepts, like the category of smooth manifolds, smooth scalar observables, their derivatives, vector bundles, tensor fields, Lie derivatives, covariant derivatives, Christoffel symbols, curvature, torsion, Riemannian manifolds, Levi-Civita connection, parallel transport, geodesics, as well as various types of curvature on Riemannian manifolds
- Apply the new techniques and solve related problems
- Structure the acquired abilities and summarize essential aspects adopting a higher standpoint
- Give a talk for peers or students on a related topic and write scientific texts or lecture notes, observing modern standards in scientific writing, in Didactics and in Pedagogy
- Provide evidence for the mastery of the Mathematical Method

Description:

Differential and Riemannian Geometries have applications in numerous fields of science, including Einstein's general theory of relativity, string theory, black holes and galaxy clusters, probability, engineering, economics, modeling and design, wireless communication and image processing, biology, chemistry, geology...

The main concept in Differential Geometry are differential manifolds - roughly, higher dimensional analogs of curves and surfaces. To be able to use efficiently these new spaces, a generalization of fundamental mathematical notions, such as derivatives and integrals, is required.

As for Riemannian manifolds, they are differential manifolds that come equipped with a metric, which then allows for concepts like length, area and volume on the manifold considered.

This metric is also an essential ingredient of the definition of the curvature of a Riemannian or pseudo-Riemannian manifold. Curvature is the most important aspect of (pseudo-) Riemannian manifolds: they are curved spaces like, for instance, the Universe. To understand the fundamental concept of curvature, a prior excursion in the world of connections (a kind of derivatives) on vector bundles (manifolds with additional structure) is indispensable.

Modalité d'enseignement:

Interactive lectures and exercise sessions

Langue:

Anglais

Obligatoire:

Non

Evaluation:

Oral or written exam

Remarque:

BIBLIOGRAPHY

1. M. P. do Carmo, Riemannian Geometry, Birkhäuser (1992)
2. W. Klingenberg, Riemannian Geometry, de Gruyter (1995)
3. John M. Lee, Riemannian Manifolds, Springer (1997)
4. P. Petersen, Riemannian Geometry, Springer (2006)

Professeur:

PONCIN Norbert, PISTALO Damjan

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Partial Differential Equations I

Module:	Specialisation - Mathematics 1 (Semestre 1)
ECTS:	8
Objectif:	The goal of the course is to get acquainted with Partial differential equations (PDE) as a powerful tool for modeling problems in science, providing functional analytic techniques in order to deal with PDE.
Course learning outcomes:	On successful completion of the course the student should be able to: <ul style="list-style-type: none">• Apply methods of Fourier Analysis to the discussion of constant coefficient differential equations• Work freely with the classical formulas in dealing with boundary value problems for the Laplace equation• Prove acquaintance with the basic properties of harmonic functions (maximum principle, mean value property) and solutions of the wave equation (Huygens property)• Solve Cauchy problems for the heat and the wave equations• Give a pedagogic talk for peers on a related topic
Description:	Fourier transform, the classical equations, spectral theory of unbounded operators, distributions, fundamental solutions.
Modalité d'enseignement:	Lecture course
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Written exam
Remarque:	1. Rudin: Functional analysis 2. Jost: Postmodern analysis 3. Folland: Introduction to partial differential equations. 4. Reed-Simon: Methods of mathematical physics I-IV
Professeur:	OLBRICH Martin, GROTTO Francesco, EL EMAM Christian

Algorithmic Number Theory

Module:	Specialisation - Mathematics 1 (Semestre 1)
ECTS:	4
Course learning outcomes:	On successful completion of the course, the student should be able to: <ul style="list-style-type: none">• Explain the main algorithms for primality testing, factorizing large integers, solving the discrete logarithm problem, both in the multiplicative group of finite fields, as well as in the context of elliptic curves defined over finite fields

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- Read and understand some scientific articles published in the domain, and ask relevant questions
- Give a talk for peers on related topics
- Organize his approach to general problems in an algorithmic way

Langue: Anglais
Obligatoire: Non
Professeur: LEPREVOST Franck

Basics of Discrete Mathematics

Module: Specialisation - Mathematics 1 (Semestre 1)
ECTS: 4
Course learning outcomes: More important than the actual content of the course (given below), is the development of the student's mathematical maturity. Upon completing this course a student should be able to:

1. recall basic concepts and tools which should be present in any science curriculum, not only in mathematics and computer science, but also in engineering and other applied sciences,
2. formulate and solve mathematically several logical and combinatorial problems arising in science as well as in quotidian life, and
3. recognize the genuine pleasure in tackling problems and the blissful joy by attaining their solution.

Description: The content includes but is not limited to:

1. Discrete calculus: sums and recurrences; manipulation of sums; multiple sums; general methods; finite calculus; summation by parts.
2. Binomial coefficients: basic identities; binomial theorem; multinomial coefficients; Vandermonde's convolution; Newton series.
3. Generating functions: basic maneuvers; solving recurrences; exponential generating functions.
4. Special numbers: Stirling numbers; Eulerian numbers; Harmonic numbers; Harmonic summations; Bernoulli numbers; Fibonacci numbers.
5. Asymptotics: O Notation, Euler's summation formula.

Modalité d'enseignement: Lecture course
Course slides
Langue: Anglais
Obligatoire: Non
Evaluation: Written exam
Remarque: **Littérature / Literatur / Literature**(recommended but not mandatory):

- R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, Addison-Wesley, 2nd edition, 2003.
- W. G. Kelley and A. C. Peterson, Difference Equations. An Introduction with Applications, Academic Press, 2nd edition, 2001.

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- C. Mariconda and A. Tonolo, Discrete Calculus. Methods for Counting, Springer, 2016.
- D. E. Knuth, The Art of Computer Programming, Volume 1: Fundamental Algorithms, 3rd edition, Addison Wesley, 1997.

Professeur: MARICHAL Jean-Luc

Probabilistic Models in Finance

Module: Specialisation - Mathematics 1 (Semestre 1)

ECTS: 6

Objectif: Introductory course to basic concepts of Mathematical Finance, also suitable for students who are not going to choose their specialization in Finance. The goal is to deepen the knowledge of modern probability theory by studying applications of general interest in an actual field of applied mathematics.

Course learning outcomes: On successful completion of the course, the student should be able to:

- Derive and apply formulas for option pricing and hedging strategies
Carry out calculations based on arbitrage arguments
- Calculate the price of European call and put options using the Cox, Ross and Rubinstein model
- Apply the techniques of Snell envelopes to evaluate American options
- Derive the classical Black-Scholes formulas as limiting case of a sequence of CRR markets

Description: Discrete financial markets, the notion of arbitrage, discrete martingale theory, martingale transforms, complete markets, the fundamental theorem of asset pricing, European and American options, hedging strategies, optimal stopping, Snell envelopes, the model of Cox, Ross and Rubinstein.

Modalité d'enseignement: Lecture course

Langue: Anglais

Obligatoire: Non

Evaluation: Written exam

Remarque: **Literature**

- D. Lamberton, B. Lapeyre: Introduction au calcul stochastique appliqué à la finance. Ellipses, 1997
- S. E. Shreve: Stochastic calculus for finance. I: The binomial asset pricing model. Springer Finance, 2004
- H. Föllmer, A. Schied: Stochastic finance. An introduction in discrete time. 2nd ed., de Gruyter, 2004
- F. Delbaen, W. Schachermayer: The mathematics of arbitrage. Springer Finance, 2006

Professeur: AMORINO Chiara

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Student Project

Module: Specialisation - Mathematics 1 (Semestre 1)

ECTS: 4

Description: The student project consists of project work that is carried out under the supervision of a professor or a postdoc. The work is either individual or group work. Group work needs the explicit approval of the Study Director.

At the beginning of the project, supervisor and student(s) define tasks to be carried out by the student(s), corresponding to the volume of 100 working hours (4 ECTS). The student(s) need to notify the Study Director of the project and the tasks at the latest on 15 October.

The project outcome is a pdf document written by the student.

Additional outcomes (such as computer code, images, videos) can be asked for.

The required outcome has to be handed in to the Study Director(s) and the supervisor at the latest on 31 December.

The student project can be done in the framework of the Experimental Mathematics Lab <https://math.uni.lu/em>

Langue: Anglais

Obligatoire: Non

Professeur: WIESE Gabor

Numerical Analysis

Module: Specialisation - Mathematics 1 (Semestre 1)

ECTS: 6

Objectif: At the end of the course, a student will be able

- to understand the main methods, the rigorous mathematical analysis and algorithms developed in numerical analysis
- to master their concrete coding starting from a pseudo-code to a Matlab implementation (that will be used as an example of programming language)
- to formulate some basic physics or engineering applications in view of their treatment by a numerical method and its computer solution.

Description: The objective of the course is to provide the main tools in numerical analysis to manage rigorously the computer solution of practical problems (physics, engineering).

The main results about the theory of numerical methods will be explained. During the course, the student will code some algorithms in Matlab to propose some concrete, robust and efficient scientific computing solutions to some concrete problems. The course content is the following:

1. Programming with Matlab

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2. Polynomial interpolation and approximation
3. Numerical derivation and integration
4. Numerical solution of Ordinary Differential Equations
5. Numerical solution of nonlinear systems of equations
6. Numerical optimization
7. Linear algebra (linear system solution, eigenvalue problems)

Langue:	Anglais
Obligatoire:	Non
Evaluation:	The evaluation will be based on a writing exam.
Remarque:	Xavier ANTOINE, Numerical Analysis, course document. Xavier ANTOINE, A Course in Matlab, course document.
Professeur:	ANTOINE Xavier

Probability (Stochastic Analysis)

Module:	Specialisation - Mathematics 1 (Semestre 1)
ECTS:	6
Objectif:	Introduction to basic concepts of Stochastic Analysis.
Description:	Continuous martingales, stochastic integration, quadratic variation, Itô calculus, theorem of Girsanov, stochastic differential equations, Markov property of solutions, connection of stochastic differential equations and partial differential equations, martingale representation theorems, chaotic expansions, Feynman-Kac formula.
Modalité d'enseignement:	Lecture course
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Written exam
Remarque:	I. Karatzas, S. Shreve: Brownian motion and stochastic calculus. 2nd edition. Springer, 1991 B. Oksendal: Stochastic differential equations. Springer, 2003 D. Revuz, M. Yor: Continuous Martingales and Brownian Motion. Springer Grundle., 1999
Professeur:	PECCATI Giovanni, PERRUCHAUD Pierre

Discrete-time stochastic processes

Module:	Specialisation - Mathematics 1 (Semestre 1)
ECTS:	6
Objectif:	Introduction to basic concepts of modern probability theory

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Course learning outcomes:	On successful completion of the course, the student should be able to: <ul style="list-style-type: none">• Understand and use concepts of modern probability theory (e.g., filtrations, martingales, stopping times)• Apply the notion of martingale to model random evolutions• Know and apply classical martingale convergence theorems• Describe and manipulate basic properties of Brownian motion
Description:	Filtrations, conditional expectations, martingales, stopping times, optional stopping, Doob inequalities, martingale convergence theorems, canonical processes, Markov semigroups and processes, Brownian motion.
Modalité d'enseignement:	Lecture course
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Written exam
Remarque:	H. Bauer, Wahrscheinlichkeitstheorie D. Williams, Probability with Martingales
Professeur:	PILIPAUSKAITE Vytautė

Complements to Graph Theory

Module:	Specialisation - Mathematics 1 (Semestre 1)
ECTS:	1
Description:	Compared to the course Introduction to Graph Theory, the student will have an additional workload that will allow him/her to get a better understanding of a selection of the course topics.
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Continuous evaluation
Professeur:	TEHEUX Bruno

Introduction to Graph Theory

Module:	Specialisation - Mathematics 1 (Semestre 1)
ECTS:	3
Objectif:	On successful completion of the course the students should be able to <ul style="list-style-type: none">• understand the relevance of the topics covered in the course for their applications,• master the proofs of the main results of the course,• solve problems using the toolkit developed in the course

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Description:	<ul style="list-style-type: none">• be autonomous in learning in the field of Graph Theory. <p>Through a presentation of selected topics, the course aims to be an introduction to graph theory, its applications and its algorithmic aspects. It is designed as a self-contained course and focused on problems pertaining to Data Science.</p> <p>Possible topics for the course include, but are not limited to</p> <ul style="list-style-type: none">• Graphs and digraphs, degree and the degree sequence algorithm• Connectedness, distance, shortest paths and connected components algorithms• Graph matching problems and algorithms• Elements of algebraic graph theory and PageRank algorithm• Graph traversal algorithms• Trees and applications• Minimum spanning tree algorithms• Network flow, min cut – max flow theorem and Ford–Fulkerson algorithm• Centrality and betweenness measures• Cluster analysis• Random Graphs
Langue:	Anglais
Obligatoire:	Non
Evaluation:	First session Oral or written exam The final grade is the maximum between the exam grade and the weighted arithmetic mean of the exam grade (weight 0.75) and the grade of the homework (weight 0.25).
Remarque:	<ul style="list-style-type: none">• R. Diestel, Graph Theory, Springer, 2017• D. Jungnickel, Graphs, Networks and algorithms, Springer 2017
Professeur:	TEHEUX Bruno

Applied Didactics I

Module:	Didactics - Mathematics 1 (Semestre 1)
ECTS:	2
Objectif:	<ul style="list-style-type: none">• Comment lire et interpréter les différents programmes de mathématiques ?• Quelle est la progression didactique à travers les 7 années de l'enseignement secondaires ?• Quelles sont les similarités et les différences entre les attentes dans les différents ordres d'enseignement/sections ?• Quelles sont les attentes finales et les questions d'examen qui les précisent ?• Comment rendre opérationnel les notions de compétences procédurales ?
Course learning outcomes:	Working through the program from a higher standpoint secondary school analysis and geometry

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Description:	<p>Le programme cadre pour l'enseignement des mathématiques dans l'enseignement secondaire classique et général :</p> <ul style="list-style-type: none">• les domaines de l'analyse et de la géométrie• les compétences à développer <p>Explicitation des finalités de l'enseignement des mathématiques à l'aide de questions d'examen</p> <p>Préparation au concours de recrutement</p> <p>Concepts-clé pour l'enseignement des mathématiques</p> <ul style="list-style-type: none">• activités mathématiques de base• apprentissage autonome• situations d'apprentissage ouvertes et complexes• résolution de problèmes
Langue:	Anglais
Obligatoire:	Oui
Professeur:	HAUSTGEN Marc Paul, COLLETTE-CLERBAUT Frédérique

Applied Didactics II

Module:	Didactics - Mathematics 1 (Semestre 1)
ECTS:	3
Objectif:	<ul style="list-style-type: none">• Comment puis-je planifier les leçons du point de vue de l'élève ?• Comment puis-je formuler le sujet, le sujet et l'objectif d'apprentissage ciblé ?• Comment vais-je analyser et préciser le sujet d'une leçon, prendre des décisions de réduction significatives et planifier en fonction des objectifs ?• Comment vais-je structurer les leçons de manière à ce que les élèves soient capables de suivre la leçon et d'agir de diverses manières ?• Comment puis-je préparer les tests et les examens en classe ?• Comment corriger et évaluer les tests et examens de mathématiques en classe ?• Comment puis-je utiliser les résultats des épreuves de manière diagnostique et remédiate ?
Description:	<ul style="list-style-type: none">• Méthodes de planification de leçons avec choix de méthodes et de formes sociales appropriées• Méthodes de communication et d'aide à la compréhension• Gestion de l'erreur dans le processus d'apprentissage• Observation, description et évaluation de processus d'apprentissage• Conception d'épreuves d'évaluation• Travail avec des grilles de compétences/indicateurs
Obligatoire:	Oui
Professeur:	BINDELS Gene

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Internship in a secondary school I

Module:	Didactics - Mathematics 1 (Semestre 1)
ECTS:	0
Langue:	Français
Obligatoire:	Oui
Evaluation:	Validated in S2

Digitale Schule (1. Semester)

Module:	Modul: Forschungsfeld Schule (Semestre 1)
ECTS:	4
Course learning outcomes:	<ul style="list-style-type: none">• Erweiterung der eigenen digitalen Kompetenzen im Hinblick auf didaktische Einbindung von digitalen Technologien im Schulunterricht• Schaffung eines medienkritischen Bewusstseins mit spezifischem Blick auf Situationen des Lehrens und des Lernens (u.a. Schülerinnen und Schülern einen selbstständigen Umgang mit digitalen Medien zu vermitteln).• Planung eigener Lehr-Lern-Arrangements.
Description:	Thema des Kurses ist der Umgang mit digitalen Technologien für den Einsatz im Schulunterricht. Dabei werden einerseits die didaktischen Potenziale derselben an Fallbeispielen erprobt, diskutiert und auch kritisch hinterfragt. Im Wechsel zwischen Praxis und Theorie werden andererseits verschiedene digitale Tools vorgestellt und durch gezielte Aufgabenstellungen vermittelt. Begleitet werden diese praxisbezogenen Studien von theoretischen Auseinandersetzungen, ebenso sind kulturelle und gesellschaftliche Aspekte der digitalen Medien Kursinhalt.
Langue:	Allemand
Obligatoire:	Oui
Evaluation:	Praktische Prüfung in Form einer Lehr-Lern-Einheit.
Remarque:	Bibliografie Wird in der Veranstaltung bekanntgegeben und über Moodle zur Verfügung gestellt.
Professeur:	HARION Dominic

Einführung in die Schulpädagogik

Module:	Modul: Forschungsfeld Schule (Semestre 1)
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ECTS:	3
Course learning outcomes:	<p>Die Studierenden haben gelernt...</p> <ul style="list-style-type: none">• Sinn, Absicht und Realität von Schule unter einem historischen, pädagogischen und soziologischen Blickwinkel zu analysieren• den Lehrerberuf als Profession zu verstehen• den Zusammenhang von Bildung, Bildungszielen und Bildungsplänen zu erkennen• Lernen als sozialen Prozess zu beschreiben.• Verschiedene Ideen davon, was „guten Unterricht“ ausmacht zu diskutieren <p>Die Studierenden sind in der Lage ...</p> <ul style="list-style-type: none">• professionelle Standards von Lehrerhandeln umzusetzen• die Bedingungen des luxemburgischen Schulsystems zu analysieren und verschiedene Theorien zur Unterrichtsqualität und Diagnostik anzuwenden
Description:	<p>Die Vorlesung „Einführung in die Schulpädagogik“ analysiert die (luxemburgische) Schule als eine historisch gewachsene Institution, die ganz unterschiedlichen Zwecken dient bzw. dienen soll. Dabei stehen pädagogische, soziologische und historische Erklärungsansätze im Mittelpunkt der Beschreibung schulischer Wirklichkeiten. Zudem werden der Lehrerberuf sowie die Schulentwicklung (Curricula, Bildungsziele etc.) auf ihre professionellen Begründungen hin vorgestellt und hinterfragt. Die Vorlesung führt ebenfalls in die wichtigsten Ideen zum Thema „Lernen“ und zur Unterrichtsqualität ein.</p>
Langue:	Allemand, Anglais
Obligatoire:	Oui
Evaluation:	Klausur
Remarque:	Bibliografie <ul style="list-style-type: none">• Ludwig Haag, Sibylle Rahm, Hans Jürgen Apel, Werner Sacher (Hrsg.): Studienbuch Schulpädagogik. Verlag Julius Klinkhardt 2013.• Hanna Kiper, Hilbert Meyer, Wilhelm Topsch (Hrsg.): Einführung in die Schulpädagogik. Cornelsen Verlag 2011.• Ilona Esslinger-Hinz, Anne Sliwka (Hrsg.): Schulpädagogik. Beltz Verlag 2011.
Professeur:	LENZ Thomas

Workshop zur Vorbereitung des Schulpraktikums für Studierende im 1. Semester.

Module:	General Competences I - Forschungsfeld Schule (Semestre 1)
ECTS:	0
Course learning outcomes:	<p>Lernziele: Die Studierenden...</p> <p>... sind vertraut mit den theoretischen Grundlagen allgemeiner Didaktik und können diese in unterrichtspraktische Anwendungsfelder übertragen.</p>



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... haben ein Basiswissen pädagogischer Diagnostik erworben und können dieses handlungsleitend in Unterrichtshospitation und Unterrichtsplanung umsetzen.

... haben ihren eigenen Wissensstand und ihre Kompetenzen in Theorie und Unterrichtspraxis reflektiert und auf dieser Basis persönliche Entwicklungsziele und Forschungsinteressen für ihr Studium identifiziert.

Description:

Der Workshop dient einerseits der Einführung in die Allgemeine Didaktik und fokussiert sowohl auf theoretische Grundlagen und praxisorientierte Umsetzung diagnostischer Verfahren zu Vorbereitung der Unterrichtshospitation wie auch auf Gestaltungsmöglichkeiten von Unterricht zur Vorbereitung der eigenen Unterrichtspraxis im Rahmen des orientierenden Praktikums.

Andererseits werden eigene Wissens- und Erfahrungsstände der Studierenden gemeinsam mit den das Praktikum begleitenden Lehrpersonen reflektiert, um individuelle Entwicklungsziele und Forschungsinteressen für das Masterstudium zu identifizieren.

Die Workshopinhalte und Lernziele sind ebenso wie die zu Grunde gelegte Literatur mit den Didaktiken der jeweiligen Fächer abgestimmt und bilden den allgemeinen bildungswissenschaftlichen Rahmen derselben.

Langue:

Allemand, Français

Obligatoire:

Non

Remarque:

Bibliographie

Ein Reader mit Grundlagentexten wird zu Beginn des Semesters über Moodle zur Verfügung gestellt. Dieser ist vor Beginn der Workshops zu bearbeiten.

Professeur:

HARION Dominic

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Semestre 2

Probability (stochastic analysis)

Module:	Module 1 (Semestre 2)
ECTS:	5
Objectif:	Introduction to basic concepts of Stochastic Analysis
Description:	Continuous martingales, stochastic integration, quadratic variation, Itô calculus, theorem of Girsanov, stochastic differential equations, Markov property of solutions, connection of stochastic differential equations and partial differential equations, martingale representation theorems, chaotic expansions, Feynman-Kac formulas
Modalité d'enseignement:	Lecture course
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Written exam
Remarque:	I. Karatzas, S. Shreve: Brownian motion and stochastic calculus. 2nd edition. Springer, 1991 B. Oksendal: Stochastic differential equations. Springer, 2003 D. Revuz, M. Yor: Continuous Martingales and Brownian Motion. Springer Grundlehren, 1999
Professeur:	PECCATI Giovanni

Homological Algebra

Module:	Module 1 (Semestre 2)
ECTS:	5
Objectif:	The objective is to allow the student to familiarize himself with a very active field of mathematics, with broad applications throughout science. Beyond this goal, special emphasizes will be put on the Mathematical Method, i.e., the optimal technique to learn and apply mathematics, in particular in order to solve real life problems using mathematical tools. This method is the most important of the objectives of any study program in mathematics.
Course learning outcomes:	On successful completion of the course, the student should be able to:

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- Explain the main definitions and results of Classical and Modern Homological Algebra
- Comment on new concepts, like the 2-category of cochain complexes in modules, the connecting homomorphism, Künneth theorem, the Mayer-Vietoris exact sequence, homotopy equivalences and deformation retracts, the Koszul, Cech, Hochschild, Chevalley-Eilenberg, and de Rham cohomologies...
- Expound homological algebra in abelian categories
- Apply the new techniques and solve problems, e.g., compute the de Rham cohomology of spheres, prove the isomorphism between the de Rham and Cech cohomologies...
- Structure the acquired abilities and summarize essential aspects adopting a higher standpoint
- Give a talk for peers or students on a related topic and write scientific texts or lecture notes, observing modern standards in scientific writing, in Didactics and in Pedagogy
- Provide evidence for the mastery of the Mathematical Method

Description: Homological algebra is roughly speaking a collection of techniques that allow scientists to extract information encoded in a widespread type of sequences of objects and arrows. It originates from topology, became an independent field of Mathematics in the mid-1940s, and developed in close connection with modern category theory. Nowadays, homological algebra plays an important role in numerous areas of Mathematics, e.g., in algebraic number theory, algebraic and differential geometry, higher algebra, graph complexes and deformation theory, operad theory, mathematical and theoretical physics... The first part of the course covers the basic concepts and the important tools. The second part is devoted to a consolidation of the knowledge acquired via exercises and applications, whereas the third part builds on the previous skills and provides insight into the modern approach to Homological Algebra in the framework of abelian category theory.

Modalité d'enseignement: Interactive lectures and exercise sessions

Langue: Anglais

Obligatoire: Non

Evaluation: Evaluation: Oral or written exam

Remarque: **Course and lecture notes under construction**

C. A. Weibel, An introduction to homological algebra, Cambridge studies in advanced mathematics 38, 1997, ISBN 0-521-55987-1

P.J. Hilton, U. Stambach, A course in homological algebra, Springer, 1997, 0-387-94823-6

S. Mac Lane, Homology, Springer, 1995, 3-540-58662-8

Professeur: PONCIN Norbert

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Partial Differential Equations II

Module:	Module 1 (Semestre 2)
ECTS:	5
Objectif:	Learning tools in order to deal with PDE, understanding the interplay between local and global problems and techniques.
Description:	Distributions as generalized functions continued, Sobolev spaces, elliptic regularity, elliptic operators on compact manifolds, some non-linear equations.
Modalité d'enseignement:	Lecture course
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Written exam
Remarque:	1. Jost: Postmodern analysis 2. Folland: Introduction to partial differential equations 3. Reed-Simon: Methods of mathematical physics I-IV 4. Aubin: Nonlinear analysis on manifolds
Professeur:	OLBRICH Martin, PALMIROTTA Guendalina

Graph theory

Module:	Module 1 (Semestre 2)
ECTS:	5
Course learning outcomes:	On successful completion of the course, the student should be able to <ul style="list-style-type: none">- Illustrate the main results and concepts with well-chosen examples- Master the proofs and techniques of the theory- Solve exercises related to the topics covered in class- Give an overview of the course content, focusing on his/her own taste and favorite topics- Communicate his/her own pleasure in solving mathematical problem

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Description:	<p>Contenu / Inhalte / Content :</p> <p>Graphs are structures that are ubiquitous in Mathematics and its applications. Through a presentation of selected topics, the course aims to be an introduction to certain modern aspects of graph theory. It is designed as a self-contained course, but some familiarity with graph theoretic notions is of course an asset.</p> <p>The exercises sessions are organized to reinforce the understanding of the topics covered in the course, and to get acquainted with the proof techniques and heuristics that are useful in Graph Theory.</p> <p>According to time and taste, topics covered will be chosen (and are not limited to) among the following ones:</p> <ul style="list-style-type: none">- Matching, covering and packing problems- Colorings- Edge and vertex connectivity- Flows and Networks- Ramsey theory for graphs- Expander graphs and applications- Graph minors and reconstruction problems- Infinite Graph Theory
Modalité d'enseignement:	Lecture course + exercises sessions
Langue:	Anglais
Obligatoire:	Non
Evaluation:	oral exam
Remarque:	Littérature / Literatur / Literature : Reinhard Diestel. Graph Theory, 5th edition. Graduate texts in mathematics 173, Springer, 2017
Professeur:	TEHEUX Bruno

Student Seminar

Module:	Module 2 (Semestre 2)
ECTS:	3
Course learning outcomes:	<p>On successful completion of the seminar, the students should be able to:</p> <ul style="list-style-type: none">- Fully benefit from seminar talks- Acquire good insight into a field by means of individual work- Give themselves lectures on specific topics- Share their knowledge with others
Description:	<p>Each student will give at least one talk on a topic selected jointly with the supervising professor. A typewritten version of this (these) lecture(s) will be requested.</p>

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Modalité d'enseignement:	Student Seminar
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Participation and lecture(s) in the seminar.
Remarque:	Provided by the supervisor
Professeur:	PERUCCA Antonella, THALMAIER Anton

Algebraic Number Theory

Module:	Module 2 (Semestre 2)
ECTS:	4
Objectif:	Introduce the students to Algebraic Number Theory.

Course learning outcomes:	On successful completion of the course, the students should be able to: <ul style="list-style-type: none">- appreciate the role played by abstract algebraic number theory for the solution of concrete Diophantine equations,- define number rings and enumerate their fundamental properties,- solve certain Diophantine equations,- outline the proofs of the fundamental results of the lecture,- apply the quadratic reciprocity law,- calculate class numbers and rings of integers in simple cases.
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Description:	Explicit Diophantine equations Number rings Cyclotomic fields Quadratic reciprocity Geometry of numbers
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Modalité d'enseignement:	Lecture with integrated exercises
Langue:	Anglais
Obligatoire:	Non

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Evaluation:	Oral exam
Remarque:	Support and Literature: to be announced in the lecture
Professeur:	PERUCCA Antonella

Introduction to Continuous Time Models in Mathematical Finance

Module:	Module 2 (Semestre 2)
ECTS:	4
Objectif:	Introduction to continuous time models in mathematical finance (Black-Scholes model)
Description:	Arbitrage, risk-neutral measures, option pricing, hedging, Black-Scholes-Merton equation, call-put parity, connections with partial differential equations, forwards and futures, american options, exotic options , change of numéraire, Garman-Kohlhagen formula, term-structure models, Vasicek model, Heath-Jarrow-Morton model, forward LIBOR model
Modalité d'enseignement:	Lecture course
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Written exam
Remarque:	M. Baxter, A. Rennie: Financial calculus. An introduction to derivative pricing. CUP, 1996 F. E. Benth: Option Theory with Stochastic Analysis. Springer, 2004 R. J. Elliot, P. E. Kopp: Mathematics of Financial Markets. 2nd ed., Springer Finance, 2004 J. C. Hull: Options, futures, and other derivatives. 6th ed., Prentice-Hall, 2005 S. E. Shreve: Stochastic calculus for finance. II: Continuous-time models. Springer, 2004 J. Michael Steele: Stochastic Calculus and Financial Mathematics. Springer, 2001
Professeur:	PECCATI Giovanni

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Numerical Analysis

Module:	Module 2 (Semestre 2)
ECTS:	4
Langue:	Français
Obligatoire:	Non
Professeur:	ANTOINE Xavier

An introduction to mathematical statistics

Module: Module 2 (Semestre 2)

ECTS: 4

Objectif: The course provides an introduction to Mathematical Statistics and addresses more specifically the problems of estimation and testing in parametric models.

Course learning outcomes: A student should be able to

- test the goodness-of-fit of the distribution of the data to some parametric models,
- estimate and test a hypothesis in parametric models. Build a confidence region for the parameter

Description:

1. Introduction the statistical paradigm and statistical models.
2. The main statistical issues I. Estimation, risk, asymptotic normality, confidence intervals. The main probabilistic tools: Markov's inequality, Hoeffding's inequality, Berry-Esseen's theorem, the central limit theorem, Slutsky's lemma, the delta method.
3. The main statistical issues II. Hypothesis testing. First and second kind errors. Construction of tests from confidence regions. The pivot method.
4. The empirical measure and its applications. The empirical moments, the empirical distribution function, the empirical variance. The moment method, Kolmogorov-Smirnov's tests, estimation based on the empirical quantiles. Robustness.
5. The maximum likelihood estimator (MLE). Example and counter-examples. Consistency of the MLE.
6. One dimensional exponential families. Properties of the MLE.
7. Tests in parametric models. The Neyman-Pearson's test, the likelihood ratio test. The monotone likelihood ratio property.

Prerequisite Course Requirement (Probability theory) : random variables, distributions, distribution functions, densities with respect to a dominating measure, expectations, basic inequalities (Markov's, Bienaymé-Tchebychev, Jensen's), independent random variables, conditional expectations, convergence in probability, convergence in distribution, the law of large numbers, the central limit theorem.

Obligatoire: Non

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Evaluation: Written exam
Remarque: Literature : Mathematical Statistics (vol 1), Bickel, P. and Doksum, K.
Professeur: BARAUD Yannick

Reading course "complements to Homological Algebra"

Module: Module 2 (Semestre 2)
ECTS: 1
Langue: Anglais
Obligatoire: Non
Professeur: PONCIN Norbert

Reading course "complements to Partial Differential Equation II"

Module: Module 2 (Semestre 2)
ECTS: 1
Langue: Anglais
Obligatoire: Non
Professeur: OLBRICH Martin

Reading course "complements to Graph Theory"

Module: Module 2 (Semestre 2)
ECTS: 1
Langue: Anglais
Obligatoire: Non
Professeur: TEHEUX Bruno

Reading course "complements to Probability (stochastic analysis)"

Module: Module 2 (Semestre 2)
ECTS: 1

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Langue: Anglais
Obligatoire: Non
Professeur: PECCATI Giovanni

Learning and teaching mathematics I

Module: Module 3 (Semestre 2)
ECTS: 2
Langue: Anglais
Obligatoire: Oui
Professeur: COLLETTE-CLERBAUT Frédérique

Hands-on experiences with mathematical didactics I

Module: Module 3 (Semestre 2)
ECTS: 3
Langue: Anglais
Obligatoire: Oui
Professeur: PERUCCA Antonella, HOLZÄPFEL Lars

Mehrsprachigkeit im Sprach- und Fachunterricht

Module: Modul: Mehrsprachigkeit und Heterogenität (Semestre 2)
ECTS: 3
Objectif: Die Studierenden haben gelernt...

- ... dass eine Sprache aus mehreren Varietäten bestehen und dass Äußerungen aus mehreren Sprachen bestehen können.
- ... dass in der Schule eine bestimmte Sprachvarietät, die „Standardsprache“ vorausgesetzt wird, diese aber nicht bei allen Schüler/innen vorausgesetzt werden kann
- ... dass Sprachen aus bestimmten formalen Einheiten bestehen (Phoneme, Morpheme, Wörter, Sätze, ...), die jeweils bestimmte Funktionen in der sprachlichen Äußerung übernehmen.
- ... dass es verschiedene Möglichkeiten gibt, Mehrsprachigkeit in den Unterricht zu integrieren (Scaffolding, Interlanguaging, CLIL, Sprachkontraste, Übersetzungen, ...)

Die Studierenden sind in der Lage ...

- ... die stillschweigende Voraussetzung der „Standardsprache“ zu erkennen und angemessene, „sprachensible“ Formen des Umgangs im Unterricht zu finden.

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- ... verschiedene Aspekte sprachsensiblen Unterrichts in Ihren Unterricht zu integrieren.
- ... Lehrwerke und Unterrichtsmaterialien nach sprachsensiblen Kriterien zu analysieren und im Unterricht einzusetzen.

Description:

Schule wird bis heute als eine Institution mit einem „monolingualen Habitus“ gesehen. Die Vorlesung hinterfragt diese institutionelle Einsprachigkeit und führt in verschiedene Aspekte von Mehrsprachigkeit ein: Was unterscheidet eine einsprachige von einer mehrsprachigen Äußerung? Wie sind mehrsprachige Praktiken strukturiert?

Aus didaktischer Perspektive wird gefragt, welche Faktoren den Spracherwerbs- bzw. Sprachlernprozess von Schüler/innen in schulischen und außerschulischen Kontexten beeinflussen und wie diese Lernprozesse im Sprachenunterricht unterstützt werden können. Hierzu werden verschiedene pädagogische Haltungen und didaktische Mittel präsentiert.

Ein wesentlicher Teil der Auseinandersetzung sprachlicher und didaktischer Mittel wird an Textaufgaben aus dem Bereich Mathematik erarbeitet, sowie an Aufgabenstellungen in den Sprachenfächern.

- Schleppegrell, M. (2004). *The Language of Schooling: A Functional Linguistics Perspective*. Mahwah, New Jersey: Lawrence Erlbaum Associates Publishers. (= d er zentrale Einstiegstext)
- García, O., & Wei, L. (2014). *Translanguaging: Language, Bilingualism and Education*. New York: Palgrave Macmillan.
- Kniffka, G., & Siebert-Ott, G. (200). *Deutsch als Zweitsprache: Lehren und Lernen*. Paderborn: Schöningh.
- Wessel, L. (2015). *Fach- und sprachintegrierte Förderung durch Darstellungsvernetzung und Scaffolding. Ein Entwicklungsforschungsprojekt zum Anteilbegriff*. Heidelberg u.a.: Springer Spektrum.

Langue:

Allemand

Obligatoire:

Oui

Evaluation:

Mitarbeit während des Seminars, semesterbegleitende Zwischenevaluation, abschließende Gruppenarbeit

Professeur:

WETH Constanze

Didaktiken der Mehrsprachigkeit

Module:

Modul: Mehrsprachigkeit und Heterogenität (Semestre 2)

ECTS:

5

Objectif:

Didaktiken der Mehrsprachigkeit: Mehrsprachigkeit aus der Perspektive von Intersektionalität (Teil I - C. Weth)

Das Seminar analysiert Mehrsprachigkeit aus der Perspektive von Intersektionalität, das heißt in der Überschneidung von Rassismus, Sexismus als Diskriminierungsprozesse und strukturelle Unterdrückungssysteme. Aus der Perspektive von Intersektionalität betrachtet, offenbart sich, dass „Mehrsprachigkeit“ sowohl ein sozioökonomisches Kapital sein kann, oder auch ein zusätzliches Element für Diskriminierung. Im Seminar wird in die Begrifflichkeit von

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Intersektionalität eingeführt und daran anschließend Formen überlegt, wie Unterricht aussehen muss, um möglichst niemanden auszuschließen.

Die Studierenden haben gelernt...

- ... was Intersektionalität bedeutet und in welchen sozialen Bereichen, strukturelle Unterdrückungsprozesse wirken können.
- ... wie Mehrsprachigkeit in Bezug zu Intersektionalität steht.
- ... dass sprachliche Ausdrucksmittel an soziale Erwartungen geknüpft sind.
- ... dass kompetente Sprecher ein Repertoire an unterschiedlichen sprachlichen Mitteln beherrschen, um Sachverhalte auszudrücken und dass Sie diese Mittel je nach Situation und Gegenüber verschieden einsetzen

Didaktiken der Mehrsprachigkeit -Approche plurielle des langues et des cultures (Teil II - A. Crais)

Les objectifs du cours sont de fournir aux étudiants les compétences pour :

- présentation de l'approche plurielle des langues et des cultures : apports / limites : discussions
- construire des scénarios d'apprentissage fondés sur l'EMILE (enseignement d'une matière par l'intégration d'une langue étrangère) qui permettent aux élèves d'acquérir des compétences interculturelles, linguistiques et métacognitives
- comprendre les stratégies à développer chez les élèves pour réussir dans leur apprentissage (différenciation pédagogique, étayage – scaffolding) avec un focus particulier sur la compréhension de l'oral et compétence de médiation

Le cours proposera

- des contenus académiques et scientifiques sur les approches plurielles notamment la didactique des langues dans un apprentissage bilingue ou dans des disciplines non linguistiques (DNL)
- un enseignement plus particulièrement fondé sur le numérique : fonctions, atouts, écueils

Course learning outcomes:

Description:

Teil I:

Im Rahmen dieses Kurses Mehrsprachigkeit aus der Perspektive von Intersektionalität analysiert und gefragt, wie im Unterricht möglichst alle Schüler/innen teilhaben können. Die Intersektionalitätsforschung zeigt auf, dass jede Form der Diskriminierung (z.B. Sexismus oder Rassismus) auf ambivalente Weise miteinander verflochten sind und im Zusammenhang betrachtet werden müssen. Bisher befasst sich Intersektionalitätsforschung relativ wenig mit Mehrsprachigkeit, sondern vor allem mit den Themenfeldern Sexismus, Rassismus und der Kategorie Behinderung. Auf Luxemburg's Mehrsprachigkeit lässt sich Intersektionalität deswegen so gut anwenden, da Mehrsprachigkeit hier ein schulischer Faktor ist, aber die Mehrsprachigkeit vor allem eine familiäre/individuelle Ressource ist.

Das Thema Intersektionalität wird in Bezug zu Themenfeldern aus der Vorlesung (Code-Switching, Translanguaging) gesetzt und praxisnah vertieft.

- Amirpur, Donja (2016). Migrationsbedingt behindert? Familien im Hilfesystem. Eine intersektionale Perspektive. Bielefeld: transcript

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- Hark, Sabine & Villa, Paula-Irene (2017). Unterscheiden und herrschen. Ein Essay zu den ambivalenten Verflechtungen von Rassismus, Sexismus und Feminismus in der Gegenwart. Bielefeld: transcript.
- Lutz, Helma & Amelina, Anna (2017). Gender, Migration, Transnationalisierung. Eine intersektionelle Einführung. Bielefeld: transcript
- Ragin, Charles C. & Fiss, Peer C. (2016). Intersectional Inequality. Race, Class, Test Scores, and Poverty. Chicago/London: The University of Chicago Press

Webseiten auf Deutsch

- <https://www.gwi-boell.de/de/intersektionalitaet>
- <https://www.deutsch-plus.de/aktuelles/broschuere-vielfalt-intersektional-verstehen/>
- <https://www.mangoes-and-bullets.org/>

Sites web en français

- <https://decadree.com/2020/04/29/kiffe-ta-race-parler-des-races-et-du-racisme/>
- <https://www.awid.org/fr/publications/lintersectionalite-un-outil-pour-la-justice-de-genre-et-la-justice-economique>
- <http://indigenes-republique.fr/race-classe-et-genre-lintersectionalite-entre-realite-sociale-et-limites-politiques/>
- <https://sse.hypotheses.org/966>
- Leisen, Josef (2013). Handbuch Sprachförderung im Fach. Sprachsensibler Fachunterricht in der Praxis. Stuttgart: Klett.
- Lukin, A., Moore, A., Herke, M., Wegener, R., & Wu, C. (2011). Halliday's model of register revisited and explored. *Linguistics and the Human Sciences*, 4(2), 187–214.
- Myers-Scotton, C. (2006). *Multiple Voices. An Introduction to Bilingualism*. (C. Myers-Scotton, Ed.). Malden, Oxford: Blackwell.
- Schleppegrell, M. (2004). *The Language of Schooling: A Functional Linguistics Perspective*. Mahwah, New Jersey: Lawrence Erlbaum Associates Publishers.
- Wiese, H. (2004). „Ich mach dich Messer“: Grammatische Produktivität in Kiez-Sprache („Kanak Sprach“). *Linguistische Berichte*, 207(April), 245–273.

Teil II:

En plus d'apports théoriques et d'exemples concrets, les étudiants seront mis en situation professionnelle dans lesquelles ils devront mettre en pratique leurs acquis et confronter leurs propositions par une approche réflexive de leur pratique.

Bibliographie : Auger, Nathalie. "Les mobilités : quels enjeux pour la didactique des langues et des cultures?." *Recherches en didactique des langues et des cultures. Les cahiers de l'Acedle* 16-2 (2019).

Candelier, Michel. "Activités métalinguistiques pour une didactique intégrée des langues." *Le français aujourd'hui* 1 (2016): 107-116.

Candelier, Michel, and Anna Schröder-Sura. "Mehrsprachigkeitsdidaktik et Didactique du plurilinguisme: Structure du champ et terminologie-Quelques repères." *Synergies Pays germanophones* 9 (2016): 33-46.

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Grabe, W. & F. Stoller. (1997). « Content-based instruction: Research foundations ». In Snow, M. & D. M. Brinton (dir.), *The Content-Based Classroom*. White Plains, NY : Addison-Wesley Longman, 78-94.

Kniffka, G., & Siebert-Ott, G. (2009). *Deutsch als Zweitsprache: Lehren und Lernen* (2. ed.). Paderborn: Schöningh.

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Tricot. André. (2016). Apprentissages scolaires et non scolaires avec le numérique. Administration & éducation, Association Française des Acteurs de l'Éducation.

Tricot, André, and Jean Rafenomanjato. (2017). "Le numérique modifie-t-il le métier d'élève?." Articles en ligne à lire pour le cours :

Stéphanie Roussel et André Tricot , « Emile/ CLIL , EMI vs TCC : des espaces de recherche si proches et si lointains », Alsic [En ligne], Vol. 20, n° 3 | 2017, mis en ligne le 10 novembre 2017, Consulté le 02 février 2020. URL : <http://journals-openedition.org.gorgone.univ-toulouse.fr/alsic/3126> ; DOI : 10.4000/alsic.3126

André Tricot , « Des idées aux situations innovantes en pédagogie », Alsic [En ligne], Vol. 22, n° 1 | 2019, mis en ligne le 15 mars 2019, Consulté le 02 février 2020. URL : <http://journals-openedition.org.gorgone.univ-toulouse.fr/alsic/3590>

Langue:	Allemand, Français
Obligatoire:	Non
Evaluation:	<ul style="list-style-type: none">• Mitarbeit während des Seminars• travail personnel sur une séquence à construire à rendre pour 15 mai• autoévaluation par le biais d'un portfolio
Professeur:	WETH Constanze, CRAIS Alexa

Sprachvariation: Wann ist eine Sprache schwer?

Module:	Modul: Mehrsprachigkeit und Heterogenität (Semestre 2)
ECTS:	5
Objectif:	<p>Ziel des Kurses ist es, in verschiedene Formen von Sprachvariation einzuführen. Ein Fokus liegt dabei auf der Verständlichkeit von Sprache. In diesem Kontext geht der Kurs auf Inklusion ein und stellt das Werkzeug der „leichten Sprache“ vor.</p> <p>Die Studierenden haben gelernt...</p> <ul style="list-style-type: none">• ... wo Sprachvariation auftritt.• ... wie wir einen Einfluss darauf haben, Texte einfacher oder schwieriger zu gestalten und welche Mittel dazu verwendet werden können.• ... was „leichte Sprache“ ist.• ... die Mittel der „leichten Sprache“ anzuwenden.
Description:	<p>In einem ersten Teil gibt der Kurs eine Einführung in die Bedeutung von ‚Sprachvariation‘ und diskutiert die Komplexität der Sprache, die uns umgibt. Zum Beispiel unterscheidet sich die Sprache in formellen Zusammenhängen grundlegend von Interaktion in der spontanen Interaktion (mündlich und schriftlich).</p> <p>Im zweiten Teil wird dargestellt, wann und für wen Sprache als besonders „schwer“ angenommen werden kann. In diesem Zusammenhang behandelt er das Thema Inklusion in einer Perspektive, die weit über die Inklusion von Menschen mit Behinderung hinausgeht.</p> <p>In einem dritten Teil gibt es eine Einführung, wie sich komplizierte Sprachstrukturen in „Leichte Sprache“ übersetzen lassen.</p> <p>Zum Abschluss des Kurses sollen die erworbenen Kenntnisse der ‚leichten Sprache‘ auf einen Bereich im Kontext der Studierenden angewendet werden (zum Beispiel die</p>



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Aufgabenstellung von Hausaufgaben, einen schulischen Brief an die Eltern, einen Schulbuch- oder Zeitungsartikel).

- Maaß, C. (2015). Leichte Sprache. Das Regelbuch. TransRelations. Retrieved from https://www.uni-hildesheim.de/media/fb3/uebersetzungswissenschaft/Leichte_Sprache_Seite/Publikationen/Regelbuch_komplett.pdf
- Bock, Bettina (2019). „Leichte Sprache“ - Kein Regelwerk. Sprachwissenschaftliche Ergebnisse und Praxisempfehlungen aus dem LeiSA Projekt. Universität Leipzig.
- Klaro, das offizielle Zentrum für Leichte Sprache in Luxemburg: <https://klaro.lu/index.php/de/>

Langue:	Allemand, Français
Obligatoire:	Non
Evaluation:	Essai über Sprachvariation und Sprachschwierigkeiten inklusive der Übersetzung eines Texts in „Leichte Sprache“ (insg. ca. 8-10 Seiten)
Professeur:	WETH Constanze

Semester 2: Workshop zur Nachbereitung des orientierenden Schulpraktikums (de)

Module:	Modul: Mehrsprachigkeit und Heterogenität (Semestre 2)
ECTS:	2
Langue:	Français
Obligatoire:	Oui
Professeur:	HARION Dominic

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Semestre 3

Student Group Project

Module:	Specialisation - Mathematics 3 (Semestre 3)
ECTS:	2
Objectif:	On successful completion of the project the student should be able to: <ul style="list-style-type: none">• cooperate effectively in a team,• analyse complex tasks• propose solution strategies,• break up a longer project into subsequent steps,• apply a variety of methods in one project,• present a task and its solution in a scientific way.

Description: The student group project consists of project work that is carried out by a group of (usually two or three) students under the supervision of a professor or a postdoc. At the beginning of the project, supervisor and students define tasks to be carried out by the students, corresponding to the volume of 50 working hours (2 ECTS). The student(s) need to notify the Study Director of the project and the tasks at the latest on 15 October. The project outcome is a pdf document written by the student. Additional outcomes (such as computer code, images, videos) can be asked for. The required outcome has to be handed in to the Study Director(s) and the supervisor at the latest on 31 December. The student project can be done in the framework of the Experimental Mathematics Lab <https://math.uni.lu/eml>

Langue:	Anglais
Obligatoire:	Non
Evaluation:	Project work
Professeur:	WIESE Gabor

Arithmetic Geometry

Module:	Specialisation - Mathematics 3 (Semestre 3)
ECTS:	6
Objectif:	<ul style="list-style-type: none">• Know examples of and be able to explain the continuity of mathematics from classical problems (as taught in school) to modern research questions.• Understand the relevance of knowing modern mathematics for being able to teach an integral picture of mathematics at secondary schools.• Be able to work with mathematical notions going beyond secondary school and Bachelor level.

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- Master the basics of local fields and be able to compute with p-adic numbers, as generalisation of the real numbers.
- Master the fundamentals of the theory of quadratic forms, be able to explain its origin in the study of conics, know and be able to apply important theorems, be able to handle examples.
- Master the basics of elliptic curves, know about their classical origin, know about their application in cryptography, understand their relevance for current number theory research, know and be able to apply important theorems, be able to handle examples.

Description:

This course leads from classical mathematics (real numbers, conics, "classical" geometry, plane curves) to some topics in modern number theory and geometry and underlines the continuity from classical geometry (as taught in school) and classical number theory to the modern points of view.

It covers p-adic numbers and more generally local fields as analogues of the real numbers, quadratic forms (arising from the study of conic sections) and elliptic curves (arising from the study of certain integrals), as well as some of their relevance for modern mathematics.

Having their origin in the study of conics, the theory of quadratic forms is a modern theory situated in both geometry and number theory with plenty of applications. It turns out that for a full classification of quadratic forms, one needs to introduce analogues for the real numbers: the so-called p-adic numbers, or, more generally, local fields. In the first part of the lecture, the theory of quadratic forms is introduced, number theory applications are treated, p-adic numbers are dealt with, and the classification theorem is fully proved.

The second part of the course is concerned with elliptic curves. These are curves arising from the study of certain integrals. They are relevant in everyday life for their fundamental role in Elliptic Curves Cryptography (e.g. used in ID cards, passports). In the language of modern geometry, they are curves of genus one with a rational point. For number theory, they appear in many of the most important questions of current research, e.g. the Birch-and-Swinnerton-Dyer conjecture, which is one of the 7 Millenium Problems. In the course, elliptic curves are introduced in modern geometric language, thus introducing this language, and several important number theoretic and geometric properties are proved, such as the addition law (making them into a group, a complicated generalisation of the integers), and statements on their rational points (number theoretic "Diophantine" question).

The course will be a classical lecture, complemented by integrated exercises and contributions by the students via short talks.

Students from the Master in Secondary Education will be asked to focus in their contributions on how to link the topics of their lectures with High School mathematics.

Langue:

Anglais

Obligatoire:

Non

Evaluation:

Students will be rated for their contributions via short talks. The number and the lengths of the short talks will depend on the number of participants and will be fixed in the beginning of the course.

Remarque:

- Serre: A course in arithmetic, Springer
- Silverman: The arithmetic of elliptic curves, Springer
- Anni, Deo, Wiese: Lecture notes for Topics in Number Theory and Geometry, distributed during the lecture

Professeur:

WIESE Gabor

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Advanced Discretization Methods

Module:	Specialisation - Mathematics 3 (Semestre 3)
ECTS:	5
Objectif:	The objectives of the course are to introduce some advanced discretization techniques for the numerical solution of partial differential equations arising in engineering and applied sciences. The schemes will be explained in details as well as their mathematical properties (e.g. order of accuracy, stability). In addition, these methods will be implemented by using Matlab and tested on concrete problems.
Course learning outcomes:	On successful completion of the course the student should be able to: <ul style="list-style-type: none">• Explain the mathematical foundation of advanced discretization techniques for PDEs• Master their concrete implementation on nontrivial engineering boundary-value problems• Adapt them according to the problem under consideration
Description:	<ol style="list-style-type: none">1. Complements the Finite Element Method2. Finite difference schemes in space3. Finite difference schemes for the discretization of time-dependent PDEs4. Introduction to integral equations
Modalité d'enseignement:	Lecture course, exercises of applications
Langue:	Anglais
Obligatoire:	Non
Evaluation:	The students will have to provide some reports that will be evaluated. In addition, a final written examination will be organized.
Remarque:	Support / Arbeitsunterlagen / Support: Lecture notes (french), exercise sheets (english)
	Littérature / Literatur / Literature <ol style="list-style-type: none">1. X. Antoine, Numerical solution of PDEs, lecture notes2. X. Antoine, Numerical Analysis, course at the University of Luxembourg3. G. Allaire, Analyse Numérique et Optimisation, Presses de l'Ecole Polytechnique4. P.A. Raviart et J.M. Thomas, Introduction à l'Analyse Numérique des Equations aux Dérivées Partielles, Dunod
Professeur:	BORDAS Stéphane

Advanced Stochastic Modelling

Module:	Specialisation - Mathematics 3 (Semestre 3)
ECTS:	5
Objectif:	Objective : The course will contain an account of the following topics:

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- *stable convergence and limit theorems
- *high frequency observations
- *estimation of financial volatility and related statistics.

**Course learning
outcomes:**

Learning outcomes : Relevant to the course subject matter the student should at the end of the course be able to:

- *reproduce key results on stable convergence, strong/weak limit theorems for Ito semimartingales, and applications to volatility estimation
- *apply the basic techniques of stable convergence and limit theorems for semimartingales to concrete examples
- *study a prescribed topic on their own and solve selected exercises with pertinent written notes.

Description:

Description : In this course we will introduce the concept of stable convergence and investigate various types of limit theorems for semimartingales applied to estimation of financial volatility. The notion of stable convergence was shown to be a very useful tool in statistical inference for stochastic processes. The first part of the lecture is concentrating around the properties of stable convergence. In the second part of the lecture we will discuss limit theorems for high frequency observations of semimartingales, which are considered as models of asset prices. We will show the relevant asymptotic results in details and present some statistical applications, which are important in mathematical finance.

**Modalité
d'enseignement:**

Lecture course

Langue:

Anglais

Obligatoire:

Non

Evaluation:

Evaluation mode : 2 hours written exam

Remarque:

T. Björk (2009). Arbitrage Theory in Continuous Time. Oxford.

P. Malliavin and A. Thalmaier (2005). Stochastic Calculus of Variations in Mathematical Finance. Springer-Verlag.

M. Musiela and M. Rutkowski (1997). Martingale Methods in Financial Modeling. Springer Verlag.

Professeur:

PODOLSKIJ Mark

Data Science

Module:

Specialisation - Mathematics 3 (Semestre 3)

ECTS:

5

Objectif:

The successful candidate understands the fundamental theoretical concepts of selected aspects of Data Science. (S)he will be able to work on appropriate solutions to data-centric problems. A continuation with concerned aspects, for example through a Master Thesis, will be motivated and supported.

**Course learning
outcomes:**

On successful completion of the course the student should be able to:

- Explain and apply the fundamental theoretical concepts of selected aspects of Data Science

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- Elaborate appropriate solutions to data-centric problems
- Deepen her/his competence in the field through a Master Thesis or self-learning

Description: The course is split into a lecture (Week 1 – 8; 13 - 14) and a seminar phase (Week 9 – 12). We concern selected aspects of

- Data Mining and Machine Learning
- Data Modeling and SQL
- Database Systems
- Data Quality and Preprocessing
- Data Privacy and Security
- Data and Information Visualization
- Information Retrieval

Modalité d'enseignement: CM (67%), SEM (33%)

Langue: Anglais

Obligatoire: Non

Evaluation: 50% Seminar, 50% Oral examination

Remarque: Support:

- Elmasri, Navathe: Fundamentals of Database Systems. Pearson Addison Wesley. 2006.
- Han, Kamber: Data Mining – Concepts and Techniques. Morgan Kaufmann. 2011.
- Manning, Raghavan, Schütze: Introduction to Information Retrieval. Cambridge University Press.
- Ware: Information Visualization. Morgan Kaufmann. 2012.
- Witten, Kamber: Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann.
- Aggarwal, Yu: Privacy-Preserving Data Mining – Models and Algorithms. Springer. 2008.
- Marz: Big Data: Principles and best practices of scalable realtime data systems. Manning. 2015.

as well as different articles, reports, and journals contributions.

Professeur: SCHOMMER Christoph

Numerical solution of partial differential equations and applications

Module: Specialisation - Mathematics 3 (Semestre 3)

ECTS: 5

Objectif: The objectives of the course are to provide to students a global overview of the finite element method. Not only the mathematical foundations will be developed but also the concrete implementation of finite element approximation techniques in view of their application to engineering problems. Some problems will be fully solved by using some computer programs written by the students (by using the PDE toolbox of Matlab or some bricks written by students).

Course learning outcomes: On successful completion of the course, the student should be able to:
- Explain the mathematical foundations of the finite element method

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	<ul style="list-style-type: none">- Master its concrete implementation for nontrivial engineering boundary-value problems- Adapt, if necessary, the finite element method to the problem under consideration
Description:	<ol style="list-style-type: none">1. Complements on Sobolev spaces; trace theorems; Green's formulae2. The Lax-Milgram theory ; variational formulations3. The Finite Element Method for stationary elliptic Partial Differential Equations (PDEs): theoretical aspects4. The Finite Element Method for stationary elliptic Partial Differential Equations (PDEs): implementation and computational aspects
Modalité d'enseignement:	Lecture course, exercises of applications
Langue:	Anglais
Obligatoire:	Non
Evaluation:	The students will have to provide some reports that will be evaluated. In addition, a final written examination will be organized.
Remarque:	Support / Arbeitsunterlagen / Support: Lecture notes (french), exercise sheets (english) Littérature / Literatur / Literature: <ol style="list-style-type: none">1) X. Antoine, Numerical solution of PDEs, lecture notes2) X. Antoine, Numerical Analysis, course at the University of Luxembourg3) G. Allaire, Analyse Numérique et Optimisation, Presses de l'Ecole Polytechnique4) P.A. Raviart et J.M. Thomas, Introduction à l'Analyse Numérique des Equations aux Dérivées Partielles, Dunod.
Professeur:	ANTOINE Xavier

Continuous-Time Stochastic Calculus and Interest Rate Models

Module:	Specialisation - Mathematics 3 (Semestre 3)
ECTS:	5
Course learning outcomes:	On successful completion of the course, the student should be able to: <ul style="list-style-type: none">• Calculate probabilities and expectations related to the semi-martingale models presented in the lectures• Carry out calculations based on change of numéraire and no-arbitrage pricing• Compute the prices of interest rate derivatives• Apply stochastic volatility models to deal with implied volatility surfaces
Description:	Basic Notions of Fixed Income Markets; Semimartingale Modeling; Stochastic Differential Equations; No-Arbitrage Pricing; Change of Numéraire; Short Rate Models; Heath-Jarrow-Morton Framework; Market Models; Stochastic Volatility.

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Modalité d'enseignement:	Lecture course
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Written exam
Remarque:	<ul style="list-style-type: none">• D. Brigo and F. Mercurio (2006) Interest Rate Models : Theory and Practice. Springer Verlag• M. Musiela and M. Rutkowski (1997) Martingale Methods in Financial Modeling. Springer Verlag
Professeur:	PECCATI Giovanni

Lie Algebras and Lie Groups

Module:	Specialisation - Mathematics 3 (Semestre 3)
ECTS:	6
Objectif:	The purpose of this course is to give an introduction into the theory of finite dimensional Lie groups and Lie algebras, assuming some basic knowledge of differentiable manifolds.
Course learning outcomes:	<p>On successful completion of the course, the student should be able to:</p> <ul style="list-style-type: none">• Expound the mathematical foundation behind symmetries of solid bodies, dynamics of mechanical systems, and geometric structures in nature.• Explain the deep interrelations between Lie groups and Lie algebras, as well as the technical tools behinds these interrelations.• Simplify mathematical problems admitting symmetry Lie groups actions to problems admitting symmetry actions of their Lie algebras.• Master applications to the theory of manifolds and representation theory, which in turn have applications in physics, engineering and mechanics.
Description:	The Lie algebra of a Lie group, the exponential map, , the adjoint representation, actions of Lie groups and Lie algebras on manifolds, the universal enveloping algebra, basics of the representation theory.
Modalité d'enseignement:	Lecture course
Langue:	Anglais
Obligatoire:	Non
Evaluation:	Written examination
Remarque:	Littérature / Literatur / Literature 1) "Lie groups and Lie algebras" by Eckhard Meinrenken, 83 pages (free to download) 2) "Prerequisites from Differential Geometry" by Sergei Merkulov (free to download)

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Professeur: MERKOULOV (MERKULOV) Serguei

Gaussian processes and applications

Module: Specialisation - Mathematics 3 (Semestre 3)

ECTS: 5

Course learning outcomes: On successful completion of the course, the student should be able to:

- Explain the language, basic concepts and techniques associated with Gaussian variables, vectors, and processes
- Identify, analyse, and prove relevant properties of models based on a Gaussian structure
- Solve exercises involving a Gaussian structure

Langue: Anglais

Obligatoire: Non

Professeur: NOURDIN Ivan

Combinatorial Geometry

Module: Specialisation - Mathematics 3 (Semestre 3)

ECTS: 6

Course learning outcomes: The course requires minimal prerequisites (some linear algebra, Euclidean geometry and basic topology) but aims to explore results that are at the limit of current known understanding. In particular, we'll discuss some open problems and try to illustrate the process of modern research. The subjects are chosen so that they can be treated with a hands-on approach, and this approach and experience are as important for this course as the actual content.

Description: The course will cover a selection of themes from combinatorial aspects of geometry.

Themes include general theorems about convex sets in n dimensional real space (and Helly type theorems), Minkovski's first theorem for lattices, and Ramsey theory (graph coloring problems).

Modalité d'enseignement: Lecture course

Langue: Anglais

Obligatoire: Non

Evaluation: Oral exam and classwork

Professeur: PARLIER Hugo, PANDA Pallavi

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Applied Didactics III

Module:	Didactics - Mathematics 3 (Semestre 3)
ECTS:	2
Langue:	Français
Obligatoire:	Oui
Professeur:	HAUSTGEN Marc Paul, COLLETTE-CLERBAUT Frédérique

Applied Didactics IV

Module:	Didactics - Mathematics 3 (Semestre 3)
ECTS:	3
Langue:	Français
Obligatoire:	Oui
Professeur:	BINDELS Gene

Internship in secondary school II

Module:	Didactics - Mathematics 3 (Semestre 3)
ECTS:	0
Langue:	Français
Obligatoire:	Oui
Evaluation:	validated in S4

Teaching Children with Special Educational Needs

Module:	Modul: Lehren und Lernen im sozialen Kontext (Semestre 3)
ECTS:	3
Course learning outcomes:	This course (lecture) is aimed to deepen students' knowledge on the latest research about the leaning processes of children with specific learning difficulties like dyslexia, specific language impairment, dyscalculia and ADHD. This course will also try to equip these future teachers with strategies aimed to more efficiently teach children with special education needs.

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Description: Over the year's research has informed the scientific and the educational community about how children's learning processes can be affected by neurologically-based difficulties. These specific learning difficulties can interfere with the learning of basic skills like reading, writing, maths or language learning. They can also interfere with higher level skills such as organization, time planning, abstract reasoning, long or short term memory and attention. As teachers, it is essential to understand the impact specific learning difficulties have on children's learning trajectories and how we can best ameliorate these difficulties.

Langue: Anglais

Obligatoire: Oui

Evaluation: Exam

Remarque: **Bibliography**

- Beck I., Mackeown M. & Kucan L. (2013). Bringing Words to Life: Robust Vocabulary Instruction. New York: Guilford.
- Carroll, J.M., Bowyer-Crane, C., Duff, F., Hulme, C., & Snowling, M.J. (2011). Effective intervention for language and literacy in the early years. Oxford: Wiley-Blackwell.
- Hulme C. & Snowling M. (2009). Developmental Disorders of Language Learning and Cognition. Oxford UK: Wiley Blackwell. Chapter 2 & 3
- Purpura, D. J., & Ganley, C. (2014). Working memory and language: Skill-specific or domain-general relations to mathematics? *Journal of Experimental Child Psychology*, 122, 104-121.
- Purpura, D. J., Napoli, A. R., Wehrspann, E. A., & Gold, Z. S. (in press). Causal connections between mathematical language and mathematical knowledge: A dialogic reading intervention. *Journal of Research on Educational Effectiveness*.
- Purpura, D. J., & Reid, E. E. (2016). Mathematics and language: Individual and group differences in mathematical language skills in young children. *Early Childhood Research Quarterly*, 26, 259-268.
- Purpura, D. J., Schmitt, S. A., & Ganley, C. M. (2017). Foundations of mathematics and literacy: The role of executive functioning components. *Journal of Experimental Child Psychology*, 153, 15-34.
- Sims, D. M., Purpura, D. J., & Lonigan, C. J. (2012). The relation between inattentive and hyperactive/impulsive behaviors and early mathematics skills. *Journal of Attention Disorders*. doi:10.1177/1087054712464390.
- Snowling, M. J., & Hulme, C. (2011). Evidence-based interventions for reading and language difficulties: Creating a virtuous circle. *British Journal of Educational Psychology*, 81(1), 1-23.

Professeur: ENGEL DE ABREU Pascale

Einführung in die Pädagogische Psychologie

Module: Modul: Lehren und Lernen im sozialen Kontext (Semestre 3)

ECTS: 3

Objetif:

- Ein (Pädagogisch-) Psychologisches Fundament für angehende Lehrerinnen und Lehrer zur Verfügung stellen
- Unterricht aus einer psychologischen Perspektive analysieren

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- Prozesse wissenschaftlichen Erkenntnisgewinns und seiner Bedeutung für die Berufspraxis nachvollziehbar machen
- Zum eigenständigen Denken und professionellem Handeln anregen
- Typische Mythen und Fehlkonzepte in Bezug auf Lernen und Unterricht aus psychologischer Sicht hinterfragen und ggf. korrigieren

Description:

Die Vorlesung führt ein in Gegenstand und Methode der (Pädagogischen) Psychologie als empirische Wissenschaft und ihrer Bedeutung für angehende LehrerInnen. Insbesondere die Pädagogische Psychologie, aber auch die Allgemeine, Differentielle, Entwicklungs- und Sozialpsychologie tragen bei zum Verständnis menschlichem Erleben und Verhalten in Kontexten der Erziehung, der Bildung und des (formalen) Lernens (bzw. Unterrichts). Vorgestellt und diskutiert werden zunächst allgemeine Inhalte und Methoden der Psychologie als empirischer Wissenschaft, allgemeine Lernvoraussetzungen (z.B. Informations-verarbeitung, Lernmotivation), Aspekte der Unterrichtsgestaltung (z.B. Klassenführung), Aspekte der sozialen Interaktion (z.B. Freundschaft, Bullying), psychologische Besonderheiten des Lehrerberufs (z.B. Lehrerpersönlichkeit, Burnout) sowie verschiedene Aspekte pädagogisch-psychologischer Diagnostik (z.B. ausgewählte Lernstörungen wie ADHS). Dabei werden sowohl empirische Originalstudien als auch empirisch fundierte Interventionsansätze zur Illustration vertiefend besprochen. Zudem werden Fallbeispiele und Übungen besprochen und durchgeführt.

Die Vorlesung ist (vorläufig) geplant als Hybrid-Format, mit regelmäßigen Live-Remote-Vorlesungen und Präsenz-Nachbesprechung einzelner Themen in Kleingruppen. Zu jeder Sitzung lädt der Dozent die Studierenden per Webex ein.

Langue:

Allemand, Anglais

Obligatoire:

Oui

Remarque:

Bibliografie

Grundlagenliteratur (d.h. online verfügbar und prüfungsrelevant, spez. Kap.)

- Fritz, A., Hussy, W. & Tobinski, D. (2018). Pädagogische Psychologie. München: Reinhardt/UTB.
- Fromm, M. (2017). Lernen und Lehren: Psychologische Grundlagen für Lehramtsstudierende. Münster: Waxmann.
- Götz, T. (2017, Hrsg.). Emotion, Motivation und selbstreguliertes Lernen. Paderborn: Schöningh/UTB.
- Imhoff, M. (2013). Psychologie für Lehramtsstudierende. Berlin: Springer.
- Kunter, M. & Trautwein, U. (2013). Psychologie des Unterrichts. Paderborn: Schöningh/UTB.
- Wild, E. & Möller, J. (2015, Hrsg.). Pädagogische Psychologie. Berlin: Springer.
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Professeur:

GRUND Axel

Digitale Schule (3. Semester)

Module:

Modul: Lehren und Lernen im sozialen Kontext (Semestre 3)

ECTS:

5

Master en Enseignement Secondaire - Master en Enseignement Secondaire, Filière Mathématiques

Objectif:	<ul style="list-style-type: none">• Extension der eigenen digitalen Kompetenzen im Hinblick auf didaktische Einbindung von digitalen Technologien im Schulunterricht• Schaffung eines medienkritischen Bewusstseins mit spezifischem Blick auf Situationen des Lehrens und des Lernens (u.a. Schülerinnen und Schülern einen selbstständigen Umgang mit digitalen Medien zu vermitteln).• Planung eigener Lehr-Lern-Arrangements.
Description:	Thema des Kurses ist der Umgang mit digitalen Technologien für den Einsatz im Schulunterricht. Dabei werden einerseits die didaktischen Potenziale derselben an Fallbeispielen erprobt, diskutiert und auch kritisch hinterfragt. Im Wechsel zwischen Praxis und Theorie werden andererseits verschiedene digitale Tools vorgestellt und durch gezielte Aufgabenstellungen vermittelt. Begleitet werden diese praxisbezogenen Studien von theoretischen Auseinandersetzungen, ebenso sind kulturelle und gesellschaftliche Aspekte der digitalen Medien Kursinhalt.
Langue:	Allemand
Obligatoire:	Oui
Evaluation:	Praktische Prüfung in Form einer Lehr-Lern-Einheit.
Remarque:	Bibliografie Wird in der Veranstaltung bekanntgegeben und über Moodle zur Verfügung gestellt.
Professeur:	BAUMANN Isabell Eva

Workshop zur Vor- und Nachbereitung des vertiefenden Schulpraktikums

Module:	Modul: Lehren und Lernen im sozialen Kontext (Semestre 3)
ECTS:	3
Course learning outcomes:	Die Studierenden haben erweiterte Kenntnisse zu Schwerpunktbereichen der allgemeinen Didaktik und Pädagogik erworben. ... verfügen über ein anwendungsbezogenes Konzeptrepertoire aus den Bereichen Instruktion, Differenzierung und Classroom Management. ... haben den eigenen Wissensstand und ihre Kompetenzen in Theorie und Unterrichtspraxis adaptiert und auf Basis ihrer individuellen Entwicklungsziele und Forschungsinteressen für ihr Studium weiterentwickelt.
Description:	Der Workshop dient der Vertiefung pädagogischer Rahmenbedingungen und didaktischer Konzepte im Enseignement Secondaire und damit der Erweiterung und Adaptation von Gestaltungsmöglichkeiten der Unterrichtspraxis im Rahmen des vertiefenden Praktikums. Ein besonderer Schwerpunkt liegt dabei auf den individuellen Entwicklungszielen und Forschungsinteressen der Studierenden, die aus der Reflexion des orientierenden Praktikums abgeleitet wurden.



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Langue: Allemand, Français

Obligatoire: Oui

Evaluation: Aktive Teilnahme an Workshop / Schulpraktikum / Praktikumsportfolio.

Remarque: **Bibliografie**

Ein Reader mit Grundlagentexten wird zu Beginn des Semesters über Moodle zur Verfügung gestellt. Dieser ist vor Beginn der Workshops zu bearbeiten.

Professeur: HARION Dominic

Master en Enseignement Secondaire - Master en Enseignement Secondaire, Filière Mathématiques

Semestre 4

Learning and teaching mathematics II

Module:	Module 4.1 (Semestre 4)
ECTS:	2
Course learning outcomes:	L'étudiant sera capable de <ul style="list-style-type: none">- décrire les aspects principaux liés à la différenciation pédagogique à savoir les contenus, les structures, les processus et les productions attendus des élèves- mettre en œuvre différentes formes de différenciation par flexibilité, adaptation et modification.- faire le lien entre différenciation pédagogique et évaluation- élaborer des documents pédagogiques permettant une différenciation en cours de mathématiques
Description:	<ul style="list-style-type: none">· Différenciation pédagogique<ul style="list-style-type: none">o Aspects théoriqueso Elaboration de situations d'apprentissage en vue d'une différenciation interneo Mise en œuvre pratique dans une classe d'un lycée· Elaboration de tâches mathématiques différenciantes
Langue:	Français
Obligatoire:	Oui
Evaluation:	Portfolio de documentation des activités élaborées et mises en œuvre suivis d'un entretien
Remarque:	Cours distribués lors de chaque séance
Professeur:	COLLETTE-CLERBAUT Frédérique

Hands-on experiences with mathematical didactics II

Module:	Module 4.1 (Semestre 4)
ECTS:	3
Langue:	Anglais

Master en Enseignement Secondaire - Master en Enseignement Secondaire, Filière Mathématiques

Obligatoire: Oui
Professeur: PERUCCA Antonella

Master Thesis

Module: Module 4.2 (Semestre 4)

ECTS: 20

Course learning outcomes: On successful completion of the Master Thesis, the students should be able to:

- Organize a comprehensive literature review
- Discuss and communicate scientific ideas
- Approach mathematical problems efficiently and identify appropriate theories or conceptual techniques
- Discover original mathematics
- Verify results and apply them
- Write mathematical texts that are consistent with the tradition

Description: The master thesis in mathematics consists of the definition of a research project, the detailed explanation of research articles and/or monographs aimed at a mathematics audience, as well as of potential further developments of these. The project, which should contain parts of original mathematics, will be designed to suit the individual objectives of the students, to deepen their competence in a selected field of mathematics, and to open a door towards mathematical research.

Langue: Anglais, Français, Allemand

Obligatoire: Oui

Evaluation: Supervisor, director of studies

Remarque: Admission to the Master Thesis will be granted only to students who acquired at least 75 ECTS credit points during the first three semesters of the Master's program (in a well-founded case, an exception to this rule might be decided by the study director).

Professeur: THALMAIER Anton, MERKOULOV (MERKULOV) Serguei

Semester 4: Workshop zur Nachbereitung des orientierenden Schulpraktikums

Module: Modul: Forschungsfeld Schule (Semestre 4)

ECTS: 2



Master en Enseignement Secondaire - Master en Enseignement Secondaire, Filière Mathématiques

Langue: Allemand
Obligatoire: Oui
Professeur: HARION Dominic

Semester 4: Professionell Auftreten

Module: Modul: Forschungsfeld Schule (Semestre 4)
ECTS: 1
Langue: Français, Allemand
Obligatoire: Non
Professeur: ULLMANN Barbara