PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

Amendment framework

TRAINING OFFER

L.M.D.

ACADEMIC LICENSE

2018 - 2019

Field	Branch	Speciality
Mathematics and computer science	Mathematics	Mathematics

الجمهورية الجزائرية الديمقراطية الشعبية
وزارة التعليم العالي و البحث العلمي

نموذج تعديل

عرض تكوين
ل. م . د

ليسانس اكاديمية

التخصص	الفرع	الميدان
رياضيات	رياضيات	رياضيات و اعلام الي

Common Core Mathematics, Applied Mathematics and Computer Science

Semester: 1

Teaching unit	Credit	Coefficient	C	TD	TP	HV	Assessment method	
						14 week	Continued	Exam
Fundamental Unit								
FTU111 : Analysis 1	6	4	3h	3h		84h	40%	60%
FTU112 : Algebra 1	5	3	1h	1h		42h	40%	60%
FTU121 : Algorithms and data structure 1	6	4	3h	1h30	3h	105h	40%	60%
FTU122 : Machine structure 1	5	3	1h30	1h30		42h	40%	60%
Methodological unit								
MTU111 : Scientific Terminology and Written Expression	2	1	1h30			21h		100%
MTU112 : Foreign language 1	2	1	1h30			21h		100%
Discovery unit								
DTU111 : Physics 1 (point mechanics)	4	2	1h30	1h30		42h	40%	60%
Total Semester 1	30	18	13h30	9h	3h	375h		

Common Core Mathematics, Applied Mathematics and Computer Science

Semester :2

Teaching unit	Credit	Coefficient	C	TD	TP	HV	Assessment method	
						14 week	Continued	Exam
Fundamental Unit								
FTU211 : Analysis 2	6	4	3h	1h30		63h	40%	60%
FTU212 : Algebra 2	4	2	1h30	1h30		42h	40%	60%
FTU221 : Algorithms and data structure 2	6	4	1h30	1h30	1h30	63h	40%	60%
FTU222 : Machine structure 2	4	2	1h30	1h30		42h	40%	60%
Methodological unit								
MTU211 : Introduction to probability and descriptive statistics	3	2	1h30	1h30		42h	40%	60%
MTU212 : Information and Communication Technology	2	1	1h30			21h		100%
MTU213 : Programming tools for mathematics	2	1	1h30		1h30	42h	40%	60%
Transversale Unit								
TTU211 : Physics 2 (general electricity)	3	2	1h30	1h30		42h	40%	60%
Total Semester 2	30	18	13h30	9h	3h	357h		

Common Core Mathematics and Applied Mathematics

Semester:3

Teaching unit	Credit	Coefficient	C	TD	TP	HV	Assessment method	
						14 week	Continued	Exam
Fundamental Unit								
FTU311 : Algebra 3	5	3	1h30	1h30		42h	40%	60%
FTU312 : Analysis 3	7	4	3h	1h30		63h	40%	60%
FTU313 : Introduction to topology	6	3	3h	1h30		63h	40%	60%
Methodological unit								
MTU311 : Numerical Analysis 1	4	3	1h30	1h30	1h30	63h	40%	60%
MTU312 : Mathematical Logic	3	2	1h30	1h30		42h	40%	60%
MTU313 : Programming Tools 2	3	1	1h30		1h30	42h	40%	60%
Discovery unit								
DTU311 : History of Mathematics	2	1	1h30			21h		100%
Total Semester 3	30	17	13h30	7h30	3h	336h		

Common Core Mathematics and Applied Mathematics

Semester : 4

Teaching unit	Credit	Coefficient	C	TD	TP	HV	Assessment method	
						14week	Continued	Exam
Fundamental Unit								
FTU411 : Analysis 4	7	4	3h	3h		84h	40%	60%
FTU412 : Algebra 4	5	3	1h30	1h30		42h	40%	60%
FTU413 : Complex analysis	6	3	3h	1h30		63h	40%	60%
Methodological unit								
MTU411 : Numerical Analysis 2	4	2	1h30	1h30	1h30	63h	40%	60%
MTU412 :probabilities	4	2	1h30	1h30		42h	40%	60%
MTU413 : Geometry	4	2	1h30	1h30		42h	40%	60%
Discovery unit								
DTU411 : Application of mathematics to other sciences	2	1	1h30			21h		100%
Total Semester 4	30	17	13h30	10h30	1h30	357h		

Mathematics License

Semester: 5

Teaching unit	Credit	Coefficient	C	TD	TP	HV	Assessment method	
						14 week	Continued	Exam
Fundamental Unit								
FTU511 : Measurement and integration	6	4	3h	1h30		63h	40%	60%
FTU512 : Normalized vector spaces	5	3	1h30	1h30		42h	40%	60%
FTU521 : Differential equations	6	4	3h	1h30		63h	40%	60%
FTU522 : Mathematical Physics Equations	5	2	1h30	1h30		42h	40%	60%
Methodological unit								
MTU511 : Optimization without constraints	5	2	1h30	1h30	1h30	63h	40%	60%
Discovery unit								
DTU511 : Introduction to mathematics education	3	1	1h30			21h		100%
Total Semester 5	30	16	12h	7h30	1h30	294h		

Mathematics License

Semester: 6

Teaching unit	Credit	Coefficient	C	TD	TP	HV	Assessment method	
						14 week	Continued	Exam
Fundamental Unit								
FTU611 : Introduction to Linear Operator Theory	9	5	3h	3h		84h	40%	60%
FTU612 : Partial Differential Equations	9	5	3h	3h		84h	40%	60%
Methodological unit								
MTU611 : Integral transformations in L^p spaces	5	2	3h	1h30		63h	40%	60%
MTU612 : Differential geometry	5	2	3h	1h30		63h	40%	60%
Transversale Unit								
Ethics and deontology of teaching and research	2	2	1h30			21h		100%
Total Semester 6	30	16	13h30	9h		315h		

Semester : 01
Teaching unit: Fundamental
Matter: Analysis1
Credits: 6
Coefficient: 4
Course objective

The objective of this matter is to familiarize students with the vocabulary of sets, to study the different methods of convergence of real sequences and the different aspects of the analysis of functions of a real variable.

Prior knowledge recommended: Mathematics of 3rd year secondary scientific and technical level.

Chapter I: The Body of Reals

$\mathbb{R}$ is a commutative field, $\mathbb{R}$ is a totally ordered field, Inductive reasoning, $\mathbb{R}$ is a valued field, Intervals, Upper and lower bounds of a subset of $\mathbb{R}$, $\mathbb{R}$ is an Archimedean field, Characterization of upper and lower bounds, The whole part function. Bounded sets, Extension of $\mathbb{R}$: Completed number line $\mathbb{R}$, Topological properties of $\mathbb{R}$, Closed open sets.

Chapter II: The Complex Number Field

Algebraic operations on complex numbers, Modulus of a complex number z, Geometric representation of a complex number, trigonometric form of a complex number, Euler formulas, exponential form of a complex number, n-th roots of a complex number.

Chapter III: Sequences of Real Numbers

Bounded sequences, convergent sequences, properties of convergent sequences, arithmetic operations on convergent sequences, extensions to infinite limits, Infinitely small and Infinitely large, Monotone sequences, extracted sequences, Cauchy sequence, generalization of the notion of the limit, Upper limit, Lower limit, Recursive sequences.

Chapter IV: Real functions of a real variable

Graph of a real function of a real variable, Even-odd functions, Periodic functions, Bounded functions, Monotone functions, Local maximum, Local minimum, Limit of a function, Limit theorems, Limit operations, Continuous functions , Discontinuities of the first and second kind, Uniform continuity, Theorems on continuous functions on a closed interval, Continuous reciprocal function, Order of an equivalence variable (Landau notation).

Chapter V: Differentiable functions

Right derivative, left derivative, Geometric interpretation of the derivative, Operations on differentiable functions, Differential Differentiable functions, Fermat’s theorem, Rolle’s theorem, Mean value theorem, Higher order derivatives, Taylor formula, Local extremum d ’a function, Bounds of a function on an interval, Convexity of a curve. Point of inflection, Asymptote of a curve, Construction of the graph of a function.

Chapter VI: Basic Functions

Natural logarithm, Natural exponential, Logarithm with any base, Power function, Hyperbolic functions, Reciprocal hyperbolic functions.

Assessment method: Examination (60%), continuous assessment (40%)

References

- J.-M. Monier, Analyse PCSI-PTSI, Dunod, Paris 2003.
- Y. Bougrov et S. Nikolski, Cours de Mathématiques Supérieures, Editions Mir, Moscou, 1983.
- N. Piskounov, Calcul différentiel et intégral, Tome 1, Editions Mir, Moscou, 1980.
- K. Allab, Eléments d’Analyse, OPU, Alger, 1984.
- B. Calvo, J. Doyen, A. Calvo, F. Boschet, Cours d’analyse, Librairie Armand Colin, Paris, 1976.
- J. Lelong-Ferrand et J. M. Arnaudiès, Cours de mathématiques, tome 2, Edition Dunod, 1978.

Semester : 01
Teaching unit: Fundamental
Matter: Algebra1
Credits: 5
Coefficient: 3
Course objective

The purpose of this matter is to introduce the basic notions of algebra and set theory.

Prior knowledge recommended: Notions of classical algebra.

Chapter I: Notions of logic.

- Truth table, quantifiers, types of reasoning.

Chapter II: Sets and applications.

- Definitions and examples.
- Applications: injection, surjection, bijection, direct image, reciprocal image, restriction and extension.

Chapter III: Binary relations on a set.

- Basic definitions: reflexive, symmetrical, antisymmetrical, transitive relation.
- Order relation- Definition. Total and partial order.
- Equivalence relation: equivalence class.

Chapter IV: Algebraic structures.

- Law of internal composition. Stable part. Properties of an internal composition law.
- Groups: Definitions. Subgroups: Examples Homomorphism of groups- isomorphism of groups. Examples of finite groups z/nz (n= 1, 2, 3,…) and the group of permutations S3.
- Rings: Definition- Under rings. Rules of calculations in a ring. Invertible elements, divisors of zero-Homomorphism of rings-Ideals.
- Field: Definitions-Treatment of the case of a finite field through the example z/pz where p is prime, $\mathbb{R}$ and C

Chapter V: Differentiable functions

- Polynomial. Degree.
- Construction of the water of the poles.
- Arithmetic of polynomials: Divisibility, Euclidean division, Pgcd and lcm of two polynomials-Polynomials prime to each other, Decomposition into a product of irreducible factors.
- Roots of a polynomial: Roots and degree, Multiplicity of roots.

Assessment method: Examination (60%), continuous assessment (40%)

References

- M. Mignotte and J. Nervi, Algebra: 1st year science license, Ellipses, Paris, 2004.
- J. Franchini and J. C. Jacquens, Algebra: course, corrected exercises, tutorials, Ellipses, Paris, 1996.
- C. Degrave and D. Degrave, Algebra 1st year: lessons, methods, solved exercises, Bréal, 2003.
- S. Balac and F. Sturm, Algebra and analysis: first year mathematics course with exercises corrected, Presses Polytechniques et Universitaires romandes, 2003.

Semester : 01
Teaching unit : Methodology
Matter: Scientific terminology and written and oral expression
Credits: 2
Coefficient: 1
Course objective

- Techniques of written expression: learn to write a memoir, make a report or a synthesis.
- Techniques of oral expression: make a presentation or a defence, learn to express oneself and communicate within a group.

Prior knowledge recommended: Knowledge of French language.

Chapter I: Scientific Terminology.

- Truth table, quantifiers, types of reasoning.

Chapter II: Technique of written and oral expression.

(report, synthesis, use of modern means of communication) in the form of presentations

Chapter III: Expression and communication in a group. As a mini group project

Assessment method: Examination (100%).

References

- L. Bellenger, L'expression orale, Que sais-je ?, Paris, P. U. F. 1979.
- Canu, Rhétorique et communication, P. Éditions Organisation-Université, 1992.
- R. Charles et C. Williame, La communication orale, Repères pratiques, Nathan, 1994.

Semester : 01
Teaching unit : Methodology
Matter: Foreign language 1
Credits: 2
Coefficient: 1
Course objective

The aim of this subject is to enable students to improve their general language skills in terms of comprehension and expression, as well as the acquisition of the specialized vocabulary of scientific and technical English.

Prior knowledge recommended: Basic knowledge in English

Chapter I: Reminders of the essential basics of English grammar.

- The times (present, past, future,…)
- Verbs: regular and irregular.
- The adjectives.
- The auxiliaries.
- Build sentences in English: affirmative, negative and interrogative, Sentence formation.
- Other structures of English grammar.

Chapter II: Vocabulary, expressions and construction of technical texts.

- Computers and the Internet: technical vocabulary.
- Construction of technical texts in English.

Assessment method: Examination (100%).

References

- Murphy. English Grammar in Use. Cambridge University Press. 3rd edition, 2004
- M. Mc Carthy et F. O'Dell, English vocabulary in use, Cambridge University Press, 1994
- L. Rozakis, English grammar for the utterly confused, Mc Graw-Hill, 1st edition, 2003
- Oxford Progressive English books.

Semester : 01
Teaching unit: Discovery
Matter: Physics 1 (point mechanics)
Credits: 4
Coefficient: 2
Course objective

At the end of this course, the student should acquire basic knowledge of point mechanics (point kinematics, point dynamics, work and energy in the case of a material point, non-conservative forces, etc.), so as to be able to analyze and interpret related phenomena.

Prior knowledge recommended: Fundamentals of Physics.

Chapter I: Point Cinematic.

- Rectilinear movement- Movement in the space
- Study of particular movements
- Study of movements in different systems (polar, cylindrical and spherical)
- Relative movements.

Chapter II: Point dynamics.

- The principle of inertia and the Galilean frames of reference.
- The principle of conservation of momentum.
- Newtonian definition of force (3 Newton's laws) - Some force laws.

Chapter III: Work and energy in the case of a material point.

- Kinetic energy- Gravitational and elastic potential energy.
- Field of forces - Non-conservative forces.

Assessment method: Examination (60%), continuous assessment (40%)

References

- A. Thionne, Mécanique du point. 2008. Editions Ellipses
- [A. Gibaud, M. Henry. Mécanique du point. Cours de physique. 2007. Editions Dunod
- S. khène, Mécanique du point matériel. 2015. Editions Sciences Physique.

Semester : 02
Teaching unit: Fundamental
Matter: Analysis2
Credits: 6
Coefficient: 4
Course objective

This subject aims to introduce students to the different aspects of integral calculus: Riemann-integral, different techniques for calculating primitives, introduction to solving differential equations.

Prior knowledge recommended: Analysis 1.

Chapter I: Indefinite integrals

Indefinite integral, Some properties of the indefinite integral, Methods of integration, Integration by change of variable, Integration by parts, Integration of rational expressions, Integration of irrational functions.

Chapter II: Definite integrals

Definite integral, Properties of definite integrals, Integral as a function of its upper bound, Newton-Leibniz formula, Cauchy-Schwarz inequality, Darboux sums-Conditions for the existence of the integral, Properties of Darboux sums, Integrability of continuous functions and monotonous.

Chapter III: First-order differential equations

General, Classification of first-order differential equations, Equation with separable variables, Homogeneous equations, Linear equations, Bernoulli's method, Method of the variation of the Lagrange constant, Bernoulli's equation, Total differential equation, Riccati's equation.

Chapter IV: Second-order differential equations with constant coefficients

Homogeneous second order differential equations with constant coefficients, Inhomogeneous second order differential equations with constant coefficients, Methods for solving second order differential equations with constant coefficients.

Assessment method: Examination (60%), continuous assessment (40%)

References

- J.-M. Monier, Analyse PCSI-PTSI, Dunod, Paris 2003.
- Y. Bougrov et S. Nikolski, Cours de Mathématiques Supérieures, Editions Mir, Moscou, 1983.
- N. Piskounov, Calcul différentiel et intégral, Tome 1, Editions Mir, Moscou, 1980.
- K. Allab, Eléments d'Analyse, OPU, Alger, 1984.
- B. Calvo, J. Doyen, A. Calvo, F. Boschet, Cours d'analyse, Librairie Armand Colin, Paris, 1976.
- J. Lelong-Ferrand et J. M. Arnaudiès, Cours de mathématiques, tome 2, Edition Dunod, 1978.

Semester : 02
Teaching unit: Fundamental
Matter: Algebra2
Credits: 4
Coefficient: 2
Course objective

Establishment of the basic principles of vector spaces.

Prior knowledge recommended: Notions of algebra.

Chapter I: Vector space.

1- Definition.
2- Under vector space.
3- Examples.
4- Free families. Generators. Basics. Dimension.
5- Finite dimensional vector space (properties).
6- Under additional vector space.

Chapter II: Linear applications.

1- Definition.
2- Image and kernel of a linear map.
3- Rank of an application, rank theorem.
4- Composed of linear applications. Inverse of a one-to-one linear map, automorphism

Chapter III: Matrices.

1- Matrix associated with a linear map.
2- Matrix operations: sum, product of two matrices, transpose matrix.
3- Vector space of matrices with n rows and m columns.
4- Ring of square dies. Determinant of a square matrix and properties. Invertible matrices.
5- Rank of a matrix (associated application). Invariance of rank by transposition.

Chapter IV: Solving systems of equations.

1- System of equations – matrix writing - rank of a system of equations.
2- Cramer's method.

Assessment method: Examination (60%), continuous assessment (40%)

References

- S. Lang : Algèbre : cours et exercices, 3ème édition, Dunod, 2004.
- E. Azoulay et J. Avignant, Mathématiques. Tome1, Analyse. Mc Graw-Hill, 1983.
- M.Mignotte et J. Nervi, Algèbre : licences sciences 1ère année, Ellipses, Paris, 2004.
- J. Franchini et J. C. Jacquens, Algèbre : cours, exercices corrigés, travaux dirigés, Ellipses, Paris, 1990

Semester : 02
Teaching unit: Methodology
Matter: Introduction to probability and descriptive statistics
Credits: 3
Coefficient: 2
Course objective

Introduce fundamental notions in probabilities and statistical series with one and two variables.

Prior knowledge recommended: Basic mathematics

Chapter I: Basic notions and statistical vocabulary

1- Basic concepts of statistics (Population and individual, Variable (or character))
2- Statistical tables: Case of qualitative variables (Circular representation by sectors, Representation in organ pipes, Band diagram), case of quantitative variables (Bar chart, Histogram, Polygon).

Chapter II: Numerical representation of data

1- The characteristics of central tendency or position (The Median, The quartiles, Interquartile range, The mode, The arithmetic mean, The weighted arithmetic mean, The geometric mean, The harmonic mean, The quadratic mean).
2- The characteristics of dispersion (range, standard deviation, mean absolute deviation, coefficient of variation).

Chapter III: Calculation of probabilities

1- Combinatorial analysis: (Fundamental principle of cobinatory analysis, Arrangements, Permutations, Combinations).
2- Probabilizable space: (Random experience, Elementary and composite events, Realization of an event, Incompatibility event, Complete event system, Algebra of events, Probabilizable space, Concept of probability).
3- Probability space: (Definitions, consequence of the definition, conditional probability, independent events, independent experiments)
4- Construction of a probability
5- Conditional probabilities, independence and composite probabilities (Conditional probabilities, Independence, Mutual independence, Compound probabilities, Bayes formula)..

Assessment method: Examination (60%), continuous assessment (40%)

References

- G. Calot, Cours de statistique descriptive, Dunod, Paris, 1973.
- P. Bailly, Exercices corrigés de statistique descriptive, OPU Alger, 1993.
- H. Hamdani, Statistique descriptive avec initiation aux méthodes d’analyse de l’information économique: exercices et corriges, OPU Alger, 2006.
- K. Redjdal, Probabilités, OPU Alger, 2004.

Semester : 02
Teaching unit: Methodology
Matter: Programming tools for mathematics
Credits: 2
Coefficient: 1
Course objective: Knowledge of scientific software
Prior knowledge recommended: Programming concepts.

Chapter I: Point Cinematic.

Mastery of Software (Matlab, Scilab, mathematica,..)

Chapter II: Point dynamics.

Examples of applications and solving techniques.

Assessment method: Examination (60%), continuous assessment (40%)

References

- Data Analysis Software: Gnu Octave, Mathematica, MATLAB, Maple, Scilab, Social Network Analysis Software, LabVIEW, Eicaslab. 2010. Editeur Books LLC., 2010.
- J.T. Lapresté., Outils mathématiques pour l'étudiant, l'ingénieur et le chercheur avec Matlab, 2008; Editeur ellipses.
- Grenier Jean-Pierre, Débuter en Algorithmique avec MATLAB et SCILAB, Editeur ellipses, 2007.

Semester : 03
Teaching unit: Transversal
Matter: Physics 2 (general electricity)
Credits: 3
Coefficient: 2

Course objective

At the end of this course, the student will have to acquire basic knowledge in electricity and magnetism (Calculation of electric and magnetic fields and potentials, Calculation of currents, etc.), so as to be able to analyze and interpret the phenomena which are linked to them.

Prior knowledge recommended: Fundamentals of Physics

Chapter I: Electrostatic

- Electrostatic forces
- Fields
- Potential
- Electric dipole
- Gaussian theorem
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Chapter II: The drivers

- Full and partial influence
- Calculation of capacities – Resistances – Laws
- Generalized ohm's law
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Chapter III: Electrokinetics

- Ohm's law
- Kirchoff's Law
- Thevenin-Norton law
-

Chapter IV: Magnetostatics

- Magnetostatic force (Lorentz and Laplace)
- Magnetic fields
- Law of Biot and Sawark
-

Assessment method: Examination (60%), continuous assessment (40%)

References

- T. Neffati. Electricité générale. 2008. Editions Dunod
- D. Bohn. . Electricité générale. 2009. Editions SAEP
- Y. Granjon. Electricité générale. 2009. Editions Dunod

Semester : 03
Teaching unit: Fundamental
Matter: Algebra 03
Credits: 5
Coefficient: 3

Course objective

Acquire the fundamental elements of algebra, namely vector spaces, multilinear algebra and the reduction of endomorphisms.

Prior knowledge recommended: Basic algebra.

Chapter I: Reminder Construction of the ring of polynomials

Chapter II: Reduction of endomorphisms of finite dimensional vector spaces.

- Eigenvalues and eigenvectors; characteristic polynomial, Cayley-Hamilton theorem
- Biagonalization of diagonalizable matrices, trigonalization, Jordan forms.
- Base change

Chapter III: Exponential of a matrix and Application to linear differential systems.

- Ohm’s law
- Kirchoff’s Law
- Thevenin-Norton law

Assessment method: Examination (60%), continuous assessment (40%)

References

- V. Prasolov. Problèmes et théorèmes d’algère linéaire.
- E. Azoulay et J. Avignant. . Mathématiques, tome 4, Algèbre.

Semester : 03
Teaching unit: Fundamental
Matter: Analysis 03
Credits: 7
Coefficient: 4
Course objective

The objective of this subject is to give students the necessary knowledge concerning simple and uniform convergences of series of functions, the development of functions in integer series and Fourier series, generalized integrals as well as functions defined by an integral.

Prior knowledge recommended: Analysis 1 and 2.

Chapter I: Numerical Series

Séries à termes réels ou complexes, Structure algébrique de l'ensemble des séries convergentes, Critère de Cauchy, Séries à termes positifs, Théorèmes de comparaison, Série de Riemann, Règle de d'Alembert, Règle de Cauchy, Règle de Cauchy-Maclaurin de l'intégrale, Série de Bertrand, Séries à termes de signes quelconques, Série de Leibniz, Séries alternées, Règle de convergence des séries alternées, Règles de convergence des séries à termes de signes quelconques, Règle de Dirichlet, Règle d'Abel, Propriétés supplémentaires des séries convergentes, Groupement de termes, Produit des séries.

Chapter II: Sequences and series of functions

Sequences of functions, Convergences, Graphical interpretation of uniform convergence, Cauchy criterion for uniform convergence, Properties of sequences of uniformly convergent functions, Series of functions, Simple convergence, Uniform convergence, Properties of series of uniformly convergent functions.

Chapter III: Integer Series

Real integer series, Cauchy-Hadamard rule, d'Alembert rule, Properties of real integer series, Taylor series, Complex integer series, Normal convergence, Weierstrass rule, Properties of complex integer series, Sums and products of integer series.

Chapter IV: Fourier series

Trigonometric series, Fourier coefficients, Fourier series of even or odd functions, Convergence rules, Some applications of Fourier series, Complex form of the Fourier series, Parseval formula.

Chapter V: Improper Integrals (Generalized)

General convergence criteria, Cauchy's rule, Absolute convergence and semi-convergence, Dirichlet's rule, Abel's rule, Relations between the convergence of integrals and the convergence of series, Principal value of Cauchy, Generalized integral of an unbounded function, Change of variable in an improper integral, Generalized integral and series, Mean formulas, Second theorem of the mean, Practical methods for the calculation of certain generalized integrals.

Chapter VI: Functions defined by an integral

Continuity, Differentiability, Integral depending on a parameter located both at the terminals and inside the integral, Uniform convergence, Uniform convergence of generalized integrals, Criteria for uniform convergence of generalized integrals, Weierstrass' rule, Dirichlet's rule , Abel's rule, Properties of a function defined by a generalized integral, Passing to the limit in the generalized integral, Integration with respect to the parameter, Unbounded function defined by a generalized integral, The form Γ (Gamma) of Euler, Euler's β (Beta) function.

Assessment method: Examination (60%), continuous assessment (40%)
References

- J. Lelong Ferrand, Exercices résolus d'analyse, Dunod, 1977.
- J. Lelong-Ferrand et J. M. Arnaudiès, Cours de mathématiques, tome 2, Edition Dunod, 1978.
- J. Rivaud, Analyse «Séries, équations différentielles» -Exercices avec solutions, Vuibert, 1981.
- C. Servien, Analyse 3 « Séries numériques, suites et séries de fonctions, Intégrales », Ellipses, 1995.

Semester : 03
Teaching unit: Fundamental
Matter: Introduction to Topology
Credits: 6
Coefficient: 3
Course objective

Its objective is to provide the basics in topology essential to any training in mathematics.

Prior knowledge recommended:

Set techniques, Elementary analysis on the real line R: The field of reals d defined as an Archimedean field containing Q and verifying the property of the upper bound, real sequences, intervals, continuous functions from R to R, derivation, algebra linear and bilinear, vector spaces, bases, linear applications, matrix calculus, determinants, scalar product, functions of several variables, partial derivatives.

Chapter I: Topological spaces

- Open, neighborhood, basis and fundamental system
- Interior and grip
- Separate space
- Induced topology
- Product topology
- Convergent sequences
- Continuous applications
- Homeomorphisms
- Topology of metric spaces: distance, ball, etc.
- Uniform continuity
- Separable metric spaces

Chapter II: Compact spaces

- Compact topological space
- Compact metric space
- Product of compact metric spaces
- Compact parts of the real line
- Continuous applications on a compact
- Locally compact spaces

Chapter III: Complete spaces

- Cauchy Suites
- Completeness
- Extension of a uniformly continuous application
- Fixed points of contractions

Chapter IV: Related spaces

- Connectivity
- Locally connected spaces.

Chapter V: Normed vector spaces

- Standards
- Distance associated with a standard
- Equivalent standards

Assessment method: Examination (60%), continuous assessment (40%)

References

- N. Bourbaki, Topologie générale, Chapitres 1 à 4. Hermann, Paris, 1971.
- G. Choquet, Cours d’analyse, tome II, Topologie. Masson, Paris, 1964.
- G. Christol, Topologie, Ellipses, Paris, 1997.
- J. Dieudonné, Éléments d’analyse, tome I : fondements de l’analyse moderne, Gauthier-Villars, Paris, 1968.
- J. Dixmier, Topologie générale, Presses universitaires de France, 1981.

Semester : 03
Teaching unit: Methodology
Matter: Numerical Analysis 1
Credits: 4
Coefficient: 3
Course objective

Introduction to numerical calculation, presentation of some methods for the approximation of functions.

Prior knowledge recommended: Mathematical analysis (Analysis 1,2 and 3).

Chapter I: Notions of errors

Decimal notation of approximate numbers - Exact digit of an approximate decimal number - Truncation and rounding error - Relative error.

Chapter II: Solving an Algebraic Equation

Dichotomy method (bisection) - Fixed point method, Newton-Raphson method - Error estimation.

Chapter III: Interpolation and Approximation

Lagrange method - Newton method - Interpolation errors - Approximation in the sense of least squares.

Chapter IV: Numerical derivation.

- Connectivity
- Locally connected spaces.
-

Chapter V: Numerical integration

Newton-Cotes formula - Trapezium method - Simpson's method - Quadrature errors.

Assessment method: Examination (60%), continuous assessment (40%)

References

- M. Atteia, M. Pradel : Eléments d'analyse numérique, Ceradues-Editions.
- J. Baranger : Introduction à l'analyse numérique, Ed. Hermann 1977.
- M. Boumahrat, A. Bourdin : Méthodes numériques appliquées. Ed. OPU 1983.
- J B. Démodovitch, I. Maron : Eléments de calcul numérique, Ed. Mir Mosco.
- G. Meurant : Résolution numérique des grands systèmes, Ed. Stanford University.

Semester : 03
Teaching unit: Methodology
Matter: Mathematical logic
Credits: 3
Coefficient: 2
Course objective

Introduction Acquire the foundations of mathematical reasoning, Acquire the foundations of set theory and acquire the elements of writing mathematical proofs.

Prior knowledge recommended: Algebra 01

Chapter I: Introduction

Elements of mathematical language: Axiom, lemma, theorem, conjecture. Writing mathematical proofs: Basic principles of writing a mathematical proof. Expression "Without loss of generality". Constructive proof and existential proof.

Chapter II: Set theory

Naive set theory. Set definition of the Cartesian product. Sets of parts. Set definition of relations. Set definition of applications. Russell's paradox. Other versions of Russel's paradox (Liar's paradox, Librarian's paradox, Cretan liar's paradox). Optional: Zermelo-Fraenkel theory. Equipotency relationship. Cardinality of sets. Cantor-Betnestein theorem. Countable set, power of the continuum. Continuity hypothesis. Paul Cohen's theorem. Axiom of choice. Godel's theorem.

Chapter III: Propositional calculus and predicate calculus

The logical proposition, conjunction, disjunction, implication, equivalence, negation. The truth table. The logical formula, the tautology, the contradiction. Rules of inference or deduction, Modus Ponens rule. Modus Tollens rule. Predicate calculus, Universal and existential quantifier, Unique existence quantifier. Multiple quantifiers, Negation of a quantifier, Quantifiers and connectors. Note: It is important to discuss logical implication in the context of classical mathematical definitions. Thus a good part of the students think that the relation $<$ in R is not an antisymmetric relation.

Chapter IV: Good order and proof by induction

Recall proof by recurrence. Proof by induction theorem. Proof by strong induction. Example of the existence of a decomposition into prime numbers of a natural number. Optional (Proof by Cauchy induction. Proof of Cauchy Scwhartz inequality by induction). Well founded order. Proof by the principle of good order. Zermelo's general good order theorem.

Assessment method: Examination (60%), continuous assessment (40%)

References

- Foundations of Mathematical logic, H.B. Curry, Dover publications, 1979.
- Calculabilité et décidabilité, J.M. Autebert, édition Dunod, 1992.
- Introduction à la théorie des ensembles, Paul Richard Halmos, Gauthier-Villars. 1967.
- Initiation au raisonnement mathématique. Logique et théorie des ensembles. Jean-Claude Dupin, Jean-Luc Valein. Armand Colin. 1993.
- How to prove it. Daniel J. Velleman. Cambridge university press.1994.

Semester : 03
Teaching unit: Discovery
Matter: History of Mathematics
Credits: 2
Coefficient: 1
Course objective

Understand civilizations and the evolution of the mathematical mind through the ages.

Prior knowledge recommended: General and scientific culture.

Chapter 1: Introduction

Chapter 2: The origins.

Chapter 3: Babylonian Mathematics.

Chapter 4: The Mathematics of Ancient Egypt.

Chapter 5: Greek, Hellenistic and Roman Mathematics.

Chapter 6: Mathematics in the Muslim East and in the Muslim West.

Chapter 7: The transmission of mathematical knowledge to Europe.

Chapter 8: Renaissance in Europe.

Chapter 9: The industrial revolution and its consequences.

Chapter 10: The 19th century and the crisis of the foundations.

Chapter 11: The 20th century and expanding scope.

Assessment method: Examination (100%),

References

رشدي راشد، تاريخ الرياضيات العربية بين الجبرو الحساب

- A.P. Youshkevitch : les Mathématiques Arabes (VIIIe-XVe siècles)
- J.P. Collette : Histoire des Mathématiques
- J. Dederon, J. Itard : Mathématiques et Mathématiciens
- A. Dahan, Dahmedice, J. Peiffer : Une histoire des mathématiques
- T.L. Heath : A history of greek mathematics
- A. Djebbar : Mathématiques et mathématiciens dans le Maghreb médiéval (Xe-XVIe siècles).

Semester : 04
Teaching unit: Fundamental
Matter: Analysis 04
Credits: 7
Coefficient: 4

Course objective

The objective of this subject is to give the necessary knowledge concerning the differentiability of a function of several variables, the generalizations of the theorems of finite increments and Taylor's formula to functions of several variables, the calculation of extrema as well as the calculation of multiple integrals.

Prior knowledge recommended: Analysis 1 and Analysis 2

Chapter I: Topology of IR^n.

Notion of norm, Open set, Open parts, Neighborhood, Closed and compact parts in IR^n.

Chapter II: Functions of several variables

Limit of a function, Continuous function, Partial derivatives along a vector, Differentiable functions, Derivative of a composite function, Gradient, Differential of a function, Differential of higher order, Schwarz's lemma, Taylor's formula, Extremums, Case functions of two variables, Calculation of the minimum and maximum of a function, Bound extremum, Theorem of implicit functions.

Chapter III: Multiple Integrals

Iterated integrals, Definition of the double integral over a rectangle, Fubini's theorem over a rectangle, Double integral over a bounded domain D, General properties of the double integral, Change of variable in a double integral, Passage into polars, The triple integral, Calculation of a triple integral on a parallelepiped, Calculation of the triple integral on a domain D, Change of variable in a triple integral, Passage into cylindrical, Passage into spherical. Applications: Calculation of volumes, surfaces.

Assessment method: Examination (60%), continuous assessment (40%)

References

- J. M. Monier, Analyse PC-PSI-PT, Dunod, Paris 2004.
- Y. Bougrov et S. Nikolski, Cours de Mathématiques Supérieures, Editions Mir, Moscou, 1983.
- N. Piskounov, Calcul différentiel et intégral, Tome 1, Editions Mir, Moscou, 1980.
- J. Lelong-Ferrand et J. M. Arnaudiès, Cours de mathématiques, tome 4, Edition Dunod, 1992.

Semester : 04
Teaching unit: Fundamental
Matter: Algebra 04
Credits: 5
Coefficient: 3

Course objective

Acquire the fundamental elements of algebra, namely linear forms, bilinear forms on a finite dimensional vector space, reduction of quadratic forms.

Prior knowledge recommended: Algebra 1, 2 and 3. Analysis 1, 2, 3

Chapter I: Linear forms – Duality (vector space and its dual)

Chapter II: Bilinear forms on a vector space

Rank - Kernel - Gaussian orthogonalization - Orthogonal matrices - Diagonalization of real symmetric matrices.

Chapter III: Spectral decomposition of a self-adjoint linear map

Chapter IV: Symmetric bilinear form and quadratic form

Gaussian decomposition (Sylvester's theorem)

Chapter V: Introduction to the Hermitian space

Assessment method: Examination (60%), continuous assessment (40%)

References

- Problèmes et théorèes d'algèbre linéaire, V. Prasolov
- Y. Mathématiques, tome 4, Algèbre, E. Azoulay et J. Avignant

Semester : 04
Teaching unit: Fundamental
Matter: Complex analysis
Credits: 6
Coefficient: 3
Course objective

Introduce the notion of a differentiable function of a complex variable, study the main properties of these functions and some of their applications (calculations of certain generalized integrals and summation of series).

Prior knowledge recommended: Analysis 1, 2.

Chapter I: Topology in the complex plane.

Algebraic properties of complex numbers.- Topological properties.- Infinity in complex analysis.
.

Chapter II: Function of complex variable

Definition of the function of the complex variable - Holomorphic functions,- analytic functions. Cauchy-Riemann condition.- Harmonic functions

Chapter III: Basic functions

Exponential function.- Logarithm function.- Circular functions.- Hyperbolic functions.- Power functions.

Chapter IV: Integral Calculus

Curvilinear integral.- Cauchy's theorem.- Cauchy integral formula.- Average formula.- Cauchy integral formula for derivatives.- Cauchy inequality.- Liouville's theorem-Morera's theorem

Chapter V: Expansion in Taylor series and in Laurent series

Taylor series expansion.- Series expansion of Laurent- Singularities isolated from a complex function.

Chapter VI: Residue theorem and its applications

Residue theorem.- Calculation of residuals.- Applications to integral calculus and summation of series. - Principle of the argument.- Rouché's theorem.

Assessment method: Examination (60%), continuous assessment (40%)

References

- M. Lavrentiev, B. Chabat, Méthode de la théorie des fontions d'une variable complexe, Edition Mir, Moscou, 1977.
- V. Smirnov, Cours de Mathématiques Supérieures, Tome 3, OPU 1985.
- W. Rudin, Analyse réelle et complexe, Cours et exercices 1987.
- John B. Conway, Functions of one complex variable, Springer-Verlag, New York 1978. 5
- B. Belaidi, Analyse Complexe Cours et Exercices Corrigés, 2002, 245 p. (En langue arabe). Deuxième édition 2009

Semester : 04

Teaching unit: Methodology

Matter: Numerical Analysis 2

Credits: 4

Coefficient: 2

Course objective: Learn the basics of matrix analysis and applications to solving linear systems.

Prior knowledge recommended: Linear algebra and matrix calculus.

Chapter I: Solving linear systems.

Reminder of notions of linear algebra - Direct methods (Methods of Gauss - Decomposition LUMethod of Cholesky) - Iterative methods (Position of the problem - Method of Jacobi - Method of Gauss-Seidel- Method of relaxation - Convergence of iterative methods)- Estimation of errors.

Chapter II: Calculation of eigenvalues and vectors

Direct method for the calculation of the eigenvalues of any matrix - Power method: calculation of the largest eigenvalue in modulus of a matrix A - Householder's method - Calculation of eigenvectors.

Chapter III: Numerical resolution of first-order ODEs

Introduction - Euler method - Taylor method of order 2 - Range-Kutta method of order 2 and 4.

Assessment method: Examination (60%), continuous assessment (40%)

References

- M. Atteia, M. Pradel : Eléments d'analyse numérique, Ceradues-Editions.
- J. Baranger : Introduction à l'analyse numérique, Ed. Hermann 1977.
- M. Boumahrat, A. Bourdin : Méthodes numériques appliquées. Ed. OPU 1983.
- B. Démodovitch, I. Maron : Eléments de calcul numérique, Ed. Mir Mosco.
- Curtis F. Gerald, P. O. Wheatdey : Applied Numerical Analysis, Addison-Wesley Pub. Compagny.
- G. Meurant : Résolution numérique des grands systèmes, Ed. Stanford University.

Semester : 04

Teaching unit: Methodology

Matter: probabilities

Credits: 3

Coefficient: 2

Course objective: This subject aims to familiarize the student with the concepts and elementary techniques of probability.

Prior knowledge recommended: Notions of basic probabilities.

Chapter I: Random variables.

One-dimensional random variables: General – Distribution function. Discrete random variables - law of probabilities - Expectation - Variance. Absolutely continuous random variables - Density function - Expectation -Variance. Probability inequalities (Markov, Jensen, Tchebychev, etc)

Chapter II: Usual probability laws

- Discrete laws: Bernoulli – Binomial-Multinomial – Hypergeometric-Poly-hypergeometric – Geometric – Poisson.
- Usual absolutely continuous probability laws: Uniform – Exponential-Normal – Weibull, Log-normal – Cauchy-Béta, Chi-square, Student, Fisher,…
- Approximations of certain laws:
  - Approximation of a hypergeometric law by a binomial law
  - Approximation of a binomial distribution by a Poisson distribution
  - Approximation of a Poisson law by a normal law
  - Approximation of a binomial distribution by a normal distribution.
- Transformations on random variables.

Assessment method: Examination (60%), continuous assessment (40%)

References

- C. Degrave, D. Degrave ; Précis de mathématiques Probabilités-Statistiques 1re et 2eme années, Cours –Méthodes-Exercices résolus, édition Bréal.
- J.-P. Lecoutre ; Statistique et probabilités, Manuel et exercices corrigés, Edition DUNOD.
- P. Bogaert Probabilités pour scientifiques et ingénieurs, Introduction au calcul des probabilités, Edition de Boeck.
- K. Redjdal, Probabilités, OPU Alger, 2004

Semester : 04
Teaching unit: Methodology
Matter: Geometry
Credits: 3
Coefficient: 2

Course objective: Acquire the basics of affine geometry and Euclidean geometry. Master the geometry of parametric curves.

Prior knowledge recommended: Algebra 1 and Algebra 2. Analysis 1 and Analysis 2. Vector functions.

Chapter I: Affine geometry.

1- Definition of an affine space
2- Notion of barycenter
3- Affine varieties affine applications and affine forms
4- Lines and Hyperplanes
5- Translation, homotheties, symmetry.

Chapter II: Euclidean affine space

1- Euclidean space structure, norm and angle, Gram-Schmidt orthonormalization
2- Under orthogonal spaces (hyperplane orthogonal to a line, distance from a point to a line, etc.)
3- Applications in Euclidean affine spaces: isometry and similarity.

Chapter III: Parameterization of curves and surfaces

1- Parametric curve: General
2- Local study of plane curves
3- Local study of left curves
4- Plotting parametric plane curves:
 - Curves in Cartesian coordinates
 - Curves in polar coordinates
5- Examples of curves and surfaces

Assessment method: Examination (60%), continuous assessment (40%)

References

- Cours de Géométrie Affine et Euclidienne pour la Licence de Mathématiques, Emmanuel Pedon, Université de Reims-Champagne Ardenne 2015.
- Géométrie , Michel Audin, Collection enseignement sup.
- Géométrie des courbes et surfaces et sous variété de IR^n, Y.Kerbrat et Braemer.

Semester : 04

Teaching unit: Discovery

Matter: Application of mathematics to other sciences

Credits: 2

Coefficient: 1

Course objective:

This course aims to show the importance of mathematics and to make it more concrete by giving examples of its practical applications.

Prior knowledge recommended: Good basics in mathematics and their applications.

The program is left to the skills of the training team.

For example :

Simple application: in Biology, Finance, Information Theory, Physics, Operational Research, etc.

Assessment method: Examination (100%).

Semester : 05
Teaching unit: Fundamental
Matter: Measur and Integration
Credits: 6
Coefficient: 4
Course objective

Make the student discover a new theory which is the theory of measurement as well as its application to probabilities, placing it in a new context of spaces which are the measured spaces, as a result a broad theory on integration is defined, in particular that of Lebesgue allowing him to become familiar with the main results of integration such as the theorem of dominated convergence of Lebesgue and the theorems of Fubini.

Prior knowledge recommended: Algebra 1 and 2, Topology

Chapter I: Tribes and measures

1- Reminders on set theory.
2- Algebras and tribes.
3- Positive measures, probability.
4- Properties of measurements, external measurements, complete measurements
5- The Lebesgue measure on the Borelian tribe .

Chapter II: Measurable functions, random variables

1- Staged functions.
2- Measurable functions and random variables.
3- Characterization of measurability.
4- Convergence p.p and convergence in measurement.

Chapter III: Integrable functions

1- Integral of a positive step function.
2- Integral of a positive measurable function.
3- Integral of a measurable function.
4- Comparison of the Lebesgue integral with the Riemann integral
5- Measurement and probability density
6- Monotone convergence and Fatou's lemma
7- The L1 space of integrable functions
8- Dominated convergence theorem in L1
9- Continuity and differentiability under the sum sign

Chapter IV: Product of measured spaces

1- Product measurement, definition
2- Fubini's theorem and consequences

Assessment method: Examination (60%), continuous assessment (40%)

References

- N. Boccara, Intégration, ellipses, 1995.
- Hadj El Amri, Mesures et intégration.
- Roger Jean, Mesures et intégration.
- O. Arino, Mesures et intégration (exercices).

Semester : 05
Teaching unit: Fundamental
Matter: Normalized Vector Spaces
Credits: 5
Coefficient: 3
Course objective

Teach students the importance of the Banach space and the particularity of the Hilbert space as being a class of normed spaces. Show results specific to this space.

Prior knowledge recommended: Analyse 1, analyse 2, analyse 3, topologie.

Chapter I: Banach space

1- Norms, equivalent norms, Banach space
2- Properties of the norm, ….
3- Examples of Banach spaces
4- Finite dimensional normed vector spaces.
5- Continuous linear maps: Definitions, norm of a continuous linear map.
6- Dual of a normed vector space

Chapter II: Hilbert space

1- Scalar product, pre-Hilbert space, Hilbert space
2- Properties of the scalar product, Cauchy-Schwarz inequality, equality of the parallelogram, ….
3- Orthogonality, projection theorem, Riesz theorem
4- Orthogonal system (Bessel-Parseval inequality), basis
5- Orthonormal systems
6- Fourier series
7- Complete orthonormal systems in concrete spaces

Assessment method: Examination (60%), continuous assessment (40%)

References

- Brezis H. Analyse Fonctionnelle, Théorie et Applications.
- Lacombe G., Massat P. Analyse Fonctionnelle. Exercices corrigés, DUNOT.
- Sonntag Y. Topologie et Analyse Fonctionnelle, Cours et exercices, Ellipses, 1997 , Gauthier&Villars.

Semester : 05

Teaching unit: Fundamental

Matter: Differential equations

Credits: 6

Coefficient: 4

Course objective

This subject teaches the fundamental notions and theorems allowing the qualitative study of ordinary differential equations.

Prior knowledge recommended: Real Analysis and Linear Algebra, topology

Chapter I: 1st order equations

1- Fundamental results
2- Local and global existence, uniqueness
3- Dependence on the initial conditions.

Chapter II: Higher-order equations-Ststems of order 1

Chapter III: Linear systems

1- Exponential of the matrix
2- Systems with second order
3- Resolving

Chapter IV: Introduction to the notions of stability.

Assessment method: Examination (60%), continuous assessment (40%)

References

- M. Roseau : Equations différentielles.
- J.P. Demailly : Analyse numérique et équations différentielles.
- F. Rideau : Exercices de calcul différentiel.
- V. Arnold : Equations différentielles ordinaires.

Semester : 05

Teaching unit: Fundamental

Matter: mathematical physics equations

Credits: 5

Coefficient: 2

Course objective

This course is supposed to provide the mathematical tools used in the technical sciences (mechanics, electrical engineering, geophysics, etc…).

Prior knowledge recommended: Real Analysis and Linear Algebra, topology

Chapter I: PDE of order 1 -Methods of characteristics

1- Linear case
2- Quasi-linear case
3- Nonlinear case

Chapter II: Second-order linear PDEs, characteristics, classification, standard shapes.

Chapter III: Method of separation of variables (of Fourier).

Chapter IV: Laplace equation, harmonic functions, Poisson kernel.

Chapter V: Wave equations (Kirchhoff formula).

Chapter VI: Equation de la chaleur (intégrale de Poisson).

Assessment method: Examination (60%), continuous assessment (40%)

References

- Nikolenko V. Equations de la physique mathématique. UM, Moscou, 1981.
- Reinhard H. Equations aux dérivées partielles. Dunod, paris, 2001.
- Baddari K, Abbassov A. Equations de la physique mathématique appliquées. OPU ; 2009.

Semester : 05

Teaching unit: Methodology

Matter: Optimization without constraints

Credits: 5

Coefficient: 2

Course objective

The module provides an introduction to unconstrained optimization. A student who has taken this course will be able to recognize the basic tools and results in optimization as well as the main methods used in practice. Practical work sessions are proposed to be implemented in particular under the scientific calculation software Matlab and this, in order to assimilate the theoretical notions of the algorithms seen in class.

Prior knowledge recommended: Basic notions of differential calculus in R^n

Chapter I: A few reminders of differential calculus, Convexity

1- Differentiability, gradient, Hessian matrix

2- Taylor expansion

3- Convex functions

Chapter II: Unconstrained minimization.

1- Existence and uniqueness results

2- 1st order optimality conditions

3- 2nd order optimality conditions

Chapter III: Algorithms

1- Gradient method

2- Conjugate gradient method

3- Newton's method

4- Relaxation method

5- Practical work

Assessment method: Examination (60%), continuous assessment (40%)

References

- M. Bierlaire, Introduction à l'optimisation différentiable, PPU', 2006.
- J-B. Hiriart-Urruty, Optimisation et analyse convexe, exercices corrigés, EDP sciences, 2009.

Semester : 05
Teaching unit: Methodology
Matter: Optimization without constraints
Credits: 3
Coefficient: 1
Course objective

This program contains three components which are: the introduction, the didactic program and some reference. The introduction contains the pedagogical orientations. The program contains the hourly volume, the expected results (end of the year) and the content.

Prior knowledge recommended: Minimum baggage of an academic

1/ Why didactics of mathematics?1- Differentiability, gradient, Hessian matrix

- The object of didactics (historical approach to the emergence and evolution of didactics, didactics and educational sciences, didactics and pedagogy).
- The systemic approach (the three poles of didactics).
- Some work in didactics (work on didactic engineering, didactic transposition, dialectic between tool-object, the conceptual field, the theory of didactic situations, the acquisition of knowledge, epistemological obstacles).

2/ How does mathematical knowledge work? (What differentiates it from the knowledge of other sciences?).

- Epistemology and the teaching of mathematics:
- Epistemology and didactics (didactics and its relationship with the history of science, the formation of mathematical notions, the epistemological characteristics and questioning didactic).
- Epistemology, representations and relationship to knowledge.
- Historical evolution for some mathematical concepts (the numbers, types of geometries,…).

3/How do students learn?

- Genetic and didactic epistemology:
- Conceptions on learning (traditional theory, behaviourism, constructivism).
- Some tendencies in cognitive psychology, the theories of ehavaviou, cognitivis, and geneti epistymology).

4/Tutorials

- Identify the influential didactic variables in the learning of mathematical notions.
- Illustrate with examples then in the field of mathematics the relationship between epistemological analysis and didactic questioning.
- Study different historical conceptions for a mathematical notion and comparison with the definitions given in school textbooks.
- Students' conceptions of mathematical notions such as: continuity, integral, differential, additive structures, whole numbers, etc.
- Identify (in a teaching program), the new notions and those that require in-depth work, then exploit the conceptual field.

Assessment method: Examination (100%)

- M. Henry (1991), Didactique Des Mathématiques, Irem De Besançon.
- Y. Chevallard & M. A. Johsua (1991), La Transposition Didactique, La Pensée Sauvage.
- R. Doudy, Rapport Enseignement-Apprentissage: Dialectique Outil- Objet ; Jeux De Cadres, Les Cahiers De Didactique N° 3, Irem De Paris Vii.
- G. Vergnaud (1991), La Théorie Des Champs Conceptuels: Recherches En Didactique Des Mathématiques N° 6, Vol. 10, N° 2 , 3.
- G. Brousseau (1983), Les Obstacles Epistémologiques Et Les Problèmes En Mathématiques, Rdm Vol. 4, N°2
- M. Artigue (1989), Epistémologie Et Didactique, Cahier De Didirem N° 3, Irem De Paris Vii.
- J. P. Astolfi & M. Develay (1989), La Didactique Des Sciences, Presses Universitaires De France.
- S. Johsua & J. J. Dupin (1993), Introduction A La Didactique Des Sciences Et Des Mathématiques, Presses Universitaires De France.
- J. P. Astolfi Et Al. (1997), Mots-Clés De La Didactique Des Sciences, De Boeck Université.
- R. Biehler & R. W. Scholz (1994), Didactics Of Mathematics As A Scientific Discipline, Mathematics Education Library.

Semester : 06
Teaching unit: Fundamental
Matter: Introduction to Linear Operator Theory
Credits: 9
Coefficient: 5
Course objective

To familiarize the student with the basic notions of the theory of linear operators to constitute a base for possible future studies in PDE, in spectral theory and in abstract differential equations

Prior knowledge recommended: Topology of metric spaces, of normed vector spaces and Hilbertian analysis

Chapter I: Linear operators

- Reminders on Banach spaces: Definitions and preliminary results, examples of Banach spaces of infinite dimension, normed vector spaces of finite dimension
- The space L(E,F) of linear operators
- Dense domain operators and extension by continuity
- Point convergence and uniform convergence
- Principle of the uniform bound
- Invertibility of linear operators

Chapter II: Linear operators and applications

- Dual of a normed vector space
- Hahn-Banach theorems: analytical form of the Hahn-Banach theorem (extension of linear forms), geometric forms of the Hahn-Banach theorem (separation of convex sets)
- Assistant Operator
- Special case: Hilbert space: generalities on Hilbert spaces, properties of the adjoint of a linear operator
- Spectrum of an operator

Chapter III: Introduction to the spectral theory of compact operators

- Definitions and results: compact operators, finite rank operators
- Spectrum of a compact operator
- Fredholm's theorems

Assessment method: Examination (60%), continuous assessment (40%)

References

- Trenoguine. Analtyse fonctionelle
- Kolmogorov, Fomine. Eléments de la théorie des fonctions et de l'analyse fonctionnelle

Semester : 06

Teaching unit: Fundamental

Matter: Partial Differential Equations

Credits: 9

Coefficient: 5

Course objective

Getting in touch with PDEs and some of the methods and problems associated with them, learning some resolution techniques of each type.

Prior knowledge recommended: Analysis, algebra, topology

Chapter I: Elliptical case

- Separations of variables
- Study of the Dirichlet problem for the Laplacian (n=2,n=3)
- (Poisson kernel, Green's functions for the ball and the half-plane)

Chapter II: Hyperbolic case – Wave equations

- By separation of variables
- Representation of the solution
- Huygens principle (n=1, n=2)
- Strings and vibrating plates (Fourier series)

Chapter III: Parabolic case – Heat equation

- By separation of variables and superposition (Fourier series)
- Representation of the solution in R^n, regularity of the solution.
- Special equations (Bernouilli-Ricati-Clairaut)

Assessment method: Examination (60%), continuous assessment (40%)

References

- J.Bass, Analyse mathématique Tome 2
- Hervé Reinhardt, Equations aux dérivées partielles-cours et exercices corrigés

Semester : 06

Teaching unit: Methodology

Matter: Integral transformations in L^p spaces

Credits: 5

Coefficient: 2

Course objective

The essential objective of this teaching is the study of two types of transformations in L^p spaces, by showing their usefulness in the resolution of certain differential equations.

Prior knowledge recommended: Topology, Measur and Integration

Chapter I: L^p spaces

- Reminders of some integration results.
- Definition and elementary properties of L^p spaces.
- Reflexibility. Separability. Dual of L^p.
- Convolution and regularization. Density theorems.

Chapter II: Fourier transform

- Fourier transform for integrable functions.
- Properties of the Fourier transformation.
- Inverse Fourier transformation.
- Fourier transform for summable square functions.

Chapter III: Laplace transform

- Definition and properties of the Laplace transformation.
- Some usual transforms.
- Inversion of the Laplace transform.
- Application to the resolution of differential equations.

Assessment method: Examination (60%), continuous assessment (40%)

References

- J. Bass, Cours de mathématiques, tome 1, Éd. Masson et Cie - Paris, 1964.
- H. Brézis, Analyse fonctionnelle, Masson, 1993.
- Yger, Espaces de Hilbert et analyse de Fourier, Cours de 3ème année de licence, université Bordeaux I, 2008.

Semester : 06
Teaching unit: Methodology
Matter: Differential geometry
Credits: 5
Coefficient: 2

Course objective

The student will learn differential calculus and integral calculus on abstract objects which are the differentiable varieties modeling real Euclidean spaces.

Prior knowledge recommended: Real Analysis and Linear Algebra

Chapter I: Local inversion theorem.

- C^r class applications. - Diffeomorphisms. - Theorem of implicit functions.

Chapter II: Rank theorem.

- The row. - Submersion theorem. - Immersion theorem. - Constant rank theorem

Chapter III: Subvarieties of R^n.

- The notion of subvariety. - Tangent spaces. - Sub varieties defined by equations.
- Sub-varieties defined by a parameter setting. - Morse's lemma.
- Tangent bundle to a submanifold of R^n.

Chapter IV: Orientations and varieties on board.

Chapter V: Differential forms and exterior differential.

- Reminders of linear algebra. - Alternating multilinear forms.
  - o Domestic product.
  - o External product.
- Differential forms. - Exterior differential. Existence and uniqueness.
- Induced differential forms and Poincaré Lemma.

Chapter VI: Integration of differential forms.

- Integration on R^n. - Integration on a variety. - The Stokes formula.
- Applications of the Stokes formula. Divergence and Green-Ostrogradski formula

Assessment method: Examination (60%), continuous assessment (40%)

References

- Cours de Mathématiques, deuxième année, Jack Dixmier.
- Introduction aux variétés différentiables, presse Université de Grenoble1996, J.J la fontaine.
- Notes de cours de géométrie différentielle, Claude Viterbo, 23-juin-2013

Semester : 06
Teaching unit: Transversal
Matter: Ethics and ontology of teaching and research
Credits: 2
Coefficient: 2

Course objective

This subject aims to prepare the future teacher on the psychological and methodological level so that he can face the mission of teaching.

Prior knowledge recommended: Minimum baggage of an academic

Teach the student how to:

- Behave with the students according to the level.
- How to deal with problems in the classroom.
- How to do a course.
- How to take an exam.
- How to maintain a healthy learning climate.
- Teaching techniques.
- Child psychology.
- Ethics and deontology.

These titles are given for information only.

Assessment method: Examination (100%).

References

- Karin Brodie, Teaching Mathematical Reasoning in Secondary School Classrooms, Springer Science+Business Media, LLC 2010.
- Pamela Cowan, Teaching Mathematicsby, Routledge, 2006.
- James A. Middleton And Polly Goepfert, Inventive Strategies For Teaching Mathematics, American Psychological Association, Washington.