PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

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2018 - 2019

Establishment	Faculty / Institut	Department
University of Mohamed Khider – Biskra	Faculty of Sciences Exact and Sciences of Nature and Life	**Mathematics**

Domain	Sector	Speciality
Mathematics and Computer science	**Mathematics**	**Mathematics**

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

عرض تكوين
ل. م . د

ليسانس أكاديمية

2018-2019

المؤسسة	الكلية/ المعهد	القسم
جامعة محمد خيضر بسكرة	العلوم الدقيقة وعلوم الطبيعة والحياة	الرياضيات

الميدان	الفرع	التخصص
رياضيات وإعلام الي	رياضيات	رياضيات

II – Form of semester organization of the courses of the Mathematics License

Common Core Mathematics, applied mathematics and computer science

Semester 1 :

Teaching unit	VHS	Weekly V.H.				Coeff	Credits	Evaluation mode	
	14 sem	C	TD	TP	personal work			Continuous	Exam
fondamentals UE									
UEF11(O/P)		4h30	4h30		6h	7	11		
UEF111 : Analysis 1	84h	3h00	3h00		3h	4	6	40%	60%
UEF112 : Algebra 1	42h	1h30	1h30		3h	3	5	40%	60%
UEF12(O/P)		4h30	3h	3h	6h	7	11		
UEF121 : Algorithms and data structure 1	105h	3h00	1h30	3h	3h	4	6	40%	60%
UEF122 : Machine structure 1	42h	1h30	1h30		3h	3	5	40%	60%
EU Methodology									
UEM11(O/P)		3h			4h	2	4		
UEM111 : Scientific terminology and written expression	21h	1h30			2h	1	2		100%
UEM112 : Foreign language	21h	1h30			2h	1	2		100%
Discovery EU									
UED11(O/P) Choose a subject among:		1h30	1h30		2h	2	4		
- Physics 1 - Electronics and system components	42h	1h30	1h30		2h	2	4	40%	60%
Total Semester 1	357h	13h30	9h	3h	18h	18	30		

Common Core Mathematics, applied mathematics and computer science

Semester 2 :

Teaching unit	VHS	Weekly V.H				Coeff	Credits	Evaluation method	
	14 sem	C	TD	TP	personal work			Continuous	Exam
fondamentals UE									
UEF21(O/P)		4h30	3h		6h	6	10		
UEF211 : Analysis 2	63h	3h00	1h30		3h	4	6	40%	60%
UEF212 : Algebra 2	42h	1h30	1h30		3h	2	4	40%	60%
UEF22(O/P)		3h	3h	1h30	6h	6	10		
UEF221 : Algorithms and data structure 2	63h	1h30	1h30	1h30	3h	4	6	40%	60%
UEF222 : Machine structure 2	42h	1h30	1h30		3h	2	4	40%	60%
UE methodology									
UEM21(O/P)		4h30	1h30	1h30	6h	4	7		
UEM211 : Introduction to probability and descriptive statistics	42h	1h30	1h30		2h	2	3	40%	60%
UEM212 : Information and Communication Technology	21h	1h30			2h	1	2		100%
UEM213 : Programming tools for mathematics	42h	1h30		1h30	2h	1	2	40%	60%
Transversal EU									
UET21(O/P)		1h30	1h30		2h	2	3		
UET211 : Physics 2 (general Electricity)	42h	1h30	1h30		2h	2	3	40%	60%
Total Semester 2	357h	13h30	9h	3h	20H	18	30		

Common Base Mathematics and applied mathematics

Semester 3 :

Teaching unit	VHS	Weekly V.H				Coeff	Credits	Evaluation method	
	14 sem	C	TD	TP	personal work			Continuous	Exam
fondamentals UE									
UEF31(O/P)		**7h30**	**4h30**		**9h**	**10**	**18**		
UEF311 : Algebra 3	**42h**	1h30	1h30		3h	3	5	40%	60%
UEF312 : Analysis 3	**63h**	3h00	1h30		3h	4	7	40%	60%
UEF313 : Introduction to Topology	**63h**	3h00	1h30		3h	3	6	40%	60%
UE méthodology									
UEM31(O/P)		**4h30**	**3h**	**3h**	**6h**	**6**	**10**		
UEM311 : Numerical analysis 1	**63h**	1h30	1h30	1h30	2h	3	4	40%	60%
UEM312 : Mathematics Logic	**42h**	1h30	1h30		2h	2	3	40%	60%
UEM313 : Programming Tools 2	**42h**	1h30		1h30	2h	1	3	40%	60%
Discovery EU									
D31(O/P)		**1h30**			**2h**	**1**	**2**		
D311 : History of Mathematics	**21h**	1h30			2h	1	2		100%
Total Semester 3	**336h**	**13h30**	**7h30**	**3h**	**17h**	**17**	**30**		

Common Base Mathematics and applied mathematics

Semester 4 :

Teaching unit	VHS	Weekly V.H				Coeff	Credits	Evaluation method	
	14 sem	C	TD	TP	personal work			Continuous	Exam
fondamentals UE									
UEF41(O /P)		**7h30**	**6h**		9h	**10**	18		
F411 : Analysis 4	**84h**	3h	3h		3h	4	7	40%	60%
F412 : Algebra 4	**42h**	1h30	1h30		3h	3	5	40%	60%
F413 : Complex Analysis	**63h**	3h	1h30		3h	3	6	40%	60%
UE méthodology									
UEM41(O/P)		**4h30**	**4h30**	**1h30**	**6h**	**6**	**10**		
M411 : Numerical analysis 2	**63h**	1h30	1h30	1H30	2h	2	4	40%	60%
M412 : Probability	**42h**	1h30	1h30		2h	2	3	40%	60%
M413 : Geometry	**42h**	1h30	1h30		2h	2	3	40%	60%
Discovery EU (O/P)									
UED41		**1h30**			**2h**	**1**	**2**		
D411 : Application of mathematics to other sciences	**21h**	1h30			2h	1	2		100%
Total Semester 4	**357h**	**13h30**	**10h30**	**1h30**	17h	**17**	**30**		

License in mathematics

Semester 5 :

Teaching unit	VHS	Weekly V.H				Coeff	Credits	Evaluation method	
	14sem	C	TD	TP	personal work			Continuous	Exam
fondamentals UE									
UEF 51 (O/P)		**4h30**	**3h**		**6h**	**7**	**11**		
UEF511: Measurement and Integration	**63h**	3h	1h30		3h	4	6	**40%**	**60%**
UEF512: Normed vector spaces	**42h**	1h30	1h30		3h	3	5	**40%**	**60%**
UEF5.2(O/P)		**4h30**	**3h**		**6h**	**6**	**11**		
UEF521 : Differential equations	**63h**	3h	1h30		3h	4	6	**40%**	**60%**
UEF5.2.2: Physics equations mathematical	**42h**	1h30	1h30		3h	2	5	**40%**	**60%**
UE méthodology									
UEM51(O/P)		**1h30**	**1h30**	**1h30**	**2h**	**2**	**5**		
UEM511 : Optimization without constraints	**63h**	1h30	1h30	1h30	2h	2	5	**40%**	**60%**
Discovery EU									
UED5.1(O/P)		**1h30**			**2h**	**1**	**3**		
UED5.1.1: Introduction to the teaching of mathematics	**21h**	1h30			2h	1	3		**100%**
Total Semester 5	**294h**	**12h**	**7h30**	**1h30**	**18h**	**16**	**30**		

License mathematics

Semester 6

Teaching unit	VHS	Weekly V.H				Coeff	Credits	Evaluation method	
	14 sem	C	TD	TP	personal work			Continuous	Exam
fondamentals UE									
UEF6.1(O/P)		**6h**	**6h**		**6h**	**10**	**18**		
UEF6.1.1 : Matter X (*)	**84h**	3h	3h		3h	5	9	**40%**	**60%**
UEF6.1.2 : Matter Y (*)	**84h**	3h	3h		3h	5	9	**40%**	**60%**
UE méthodology									
UEM6.1(O/P)		**3h**	**3h**	**1h30**	**4h**	**4**	**10**		
UEM6.1.1 : Integral transforms in Lp spaces	**63h**	3h	1h30		2h	2	5	**40%**	**60%**
UEM6.1.2 : Differential geometry	**63h**	3h	1h30		2h	2	5	**40%**	**60%**
Transversal EU									
UET6.1 (O/P)		**1h30**			**2h**	**2**	**2**		
Ethics and professional conduct of teaching and research	**21h**	1h30			2h	2	2		**100%**
Total Semester 6	**315h**	**13h30**	**9h**	**1h30**	**26h**	**16**	**30**		

(*) subjects X and Y are to be chosen in pairs (one or more) by **the training team** from the following list. This list remains open to new proposals which must be **validated by the CPND**

Introduction to group theory	Introduction to the theory of linear operatorsEqua
Theory of bodies	Partial differential equations
Inferential Statistics	Mathematical modeling of the rhythms of life
Advanced probabilities	Optimization with constraints
Introduction to random processes	Linear programming
Numerical methods for EDO and PDE	

NB: To share the 3 hours between TD and TP depending on subjects X and Y chosen by the establishment.

Overall summary of the training: (indicate the separate overall VH in progress, TD, TP… for the 06 semesters of teaching, for the different types of EU)

UE / VH	UEF	UEM	UED	UET	Total
Course	651h	336h	84h	42h	**1071h**
TD	462h	189h	21h	21h	**735h**
TP	105h	105h	00	00	**210h**
Personal work	840h	392h	112h	56h	**1400h**
Other (specify)					
Total	**2058h**	**1022h**	**217h**	**119h**	**3416h**
Credits	**118**	**46**	**11**	**5**	**180**
% in credits for each UE	**65,5%**	**25,5%**	**6,11%**	**2,7%**	**100%**

III - Detailed program by subject of the semesters
(1 detailed sheet per subject)

(All fields must be completed)

Semester : 01
Teaching unit: Fundamental
Module: Analysis 1
Credits : 6
Coefficient : 4
Course objective:

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

Recommended prior knowledge: Final year level.

Chapiter I : The field of Real numbers

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

Chapiter II : The field of complex numbers

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, Nth roots of a complex number.

Chapiter III : Sequence of real Nombers

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 notion of the limit, Upper limit, Lower limit, recurring sequences.

Chapiter IV : Real Functions of a real variable

Graph of a real function of a real variable, Even-odd functions, Periodic functions, Bounded functions, Monotonic 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).

Chapiter 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, Finite increment theorem, Higher order derivatives, Taylor formula, Local extremum of a function, Bounds of a function on an interval, Convexity of a curve. Inflection point, Asymptote of a curve, Construction of the graph of a function.

Chapiter VI : Elementary Functions

Logarithme népérien, Exponentielle népérienne, Logarithme de base quelconque, Fonction puissance, Fonctions hyperboliques, Fonctions hyperboliques réciproques.

Evaluation mode : Exam (60%) , continuous control (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
Module : Algebra1
Credits : 5
Coefficient : 3
Teaching objectives:
This module introduces the basic notions of algebra and set theory.
Recommended prior knowledge: Basic algebra.
Content of the module:
Chapiter 1 : Notions of logic

- Truth table, quantifiers, types of reasoning.

Chapiter 2 : Sets and applications.

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

Chapiter 3 : Binary relations on a set.

- Basic definitions: reflexive, symmetric, antisymmetric, transitive relation.
- Order relationship - Definition. Total and partial order.
- Equivalence relation: equivalence class.

Chapiter 4 : Algebraic structures.

- Law of internal composition. Stable part. Properties of an internal composition law.
- Groups-Definitions. Subgroup-Examples-Homomorphism of groups-isomorphism of groups.Give examples of finite groups Z/nZ (n= 1, 2, 3,…) and the group of permutations S_3.
- Rings-Definition, Sub- rings. Calculation rules in a ring. Invertible elements, divisors of zero-Homomorphism of rings-Ideals.
- Field-Definitions-Treat the case of a finite body through the example Z/pZ where p is prime, R and C

Chapiter 5 : Rings of polynomials.

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

Evaluation mode : Exam (60%) , continuous control (40%)
References

- 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, Ellipes, Paris, 1996.
- C. Degrave et D. Degrave, Algèbre 1ère année : cours, méthodes, exercices résolus, Bréal, 2003.
- S. Balac et F. Sturm, Algèbre et analyse : cours de mathématiques de première année avec exercices corrigés, Presses Polytechniques et Universitaires, 2003.

Semester : 01
Teaching unit: Fundamental
Module : Algorithms and data structure 1
Credits : 6
Coefficient : 4

Teaching objectives: Present the concepts of algorithm and data structure.
Recommended prior knowledge: Basic computer science and mathematics.

Content of the module:

Chapter 1: Introduction

1. Brief history of computing
2. Introduction to algorithms

Chapter 2: Simple sequential algorithm

1. Concept of language and algorithmic language
2. Parts of an algorithm
3. Data: variables and constants
4. Data Types
5. Basic Operations
6. Basic Instructions
   - Assignments
   - Input/Output Instructions
7. Construction of a simple algorithm
8. presentation of an algorithm by a flowchart
9. C language translation

Chapter 3: Conditional structures (in algorithmic language and in C)

1. Introduction
2. Simple conditional structure
3. Compound conditional structure
4. Multiple choice conditional structure
5. The hookup

Chapter 4: Loops (in algorithmic language and in C)

1. Introduction
2. The While loop
3. The Repeat loop
4. The Pour loop
5. Nested loops

Chapter 5: Arrays and strings

1. Introduction
2. The array type
3. Multidimensional arrays
4. Character strings

Chapter 6: Custom Types

1. Introduction
2. Enumerations
3. Records (Structures)
4. Other type definition possibilities

NB : TP of C, it must be complementary of TD .

Evaluation mode : Exam (60%) , continuous control (40%)

References

- Thomas H. Cormen, Algorithmes Notions de base *Collection : Sciences Sup, Dunod,* 2013.
- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest Algorithmique - 3ème édition - Cours avec 957 exercices et 158 problèmes Broché, Dunod, 2010.
- Rémy Malgouyres, Rita Zrour et Fabien Feschet. *Initiation à l'algorithmique et à la programmation en C : cours avec 129 exercices corrigés*. 2ième Edition. Dunod, Paris, 2011. ISBN : 978-2-10-055703-5.
- Damien Berthet et Vincent Labatut. *Algorithmique & programmation en langage C - vol.1 : Supports de cours*. Licence. Algorithmique et Programmation, Istanbul, Turquie. 2014, pp.232.
- Damien Berthet et Vincent Labatut. *Algorithmique & programmation en langage C - vol.2 : Sujets de travaux pratiques*. Licence. Algorithmique et Programmation, Istanbul, Turquie. 2014, pp.258. <cel-01176120>
- Damien Berthet et Vincent Labatut. *Algorithmique & programmation en langage C - vol.3 : Corrigés de travaux pratiques*. Licence. Algorithmique et Programmation, Istanbul, Turquie. 2014, pp.217. <cel-01176121>
- Claude Delannoy. *Apprendre à programmer en Turbo C*. Chihab- EYROLLES, 1994.

Semester : 01
Teaching unit: Fundamental
Module : Machine structure 1
Credits : 5
Coefficient : 3
Teaching objectives:
The aim of this subject is to present and deepen the concepts concerning the different numbering systems as well as the representation of information, whether numerical or character. The basics of Boolean algebra are also covered in depth.

Recommended prior knowledge:
Elementary mathematics.

Content of the module:
Chapiter 1 :
- General Introduction.

Chapiter 2 : The systems of numbering
- Definition
- Presentation of decimal, binary, octal and hexadecimal systems.
- Conversion between these different systems.
- Basic operations in the binary system:
  - Addition
  - Substraction
  - Multiplication
  - Division

Chapiter 3 : The representation of information
- Binary coding:
  - Pure binary coding.
  - The reflected binary code (or DE GRAY code)
  - The DCB code (Binary coded decimal)
  - The code exceeds three.
- Character representation:
  - Code EBCDIC
  - Code ASCII
  - Code UTF.
- Representation of numbers :

1- Entire Numbers :
  - Unsigned representation.
  - Representation with sign and absolute value.
  - Complement of 1 (or Restricted complement)
  - 2's Complement (or True Complement)

2- Fractional numbers:
  - Fixed comma.
  - Floating comma (norm IEEE 754)

Chapiter 4 : Binary Boolean algebra
- Definition and axioms of Boolean algebra.
- Theorems and properties of Boolean algebra.
- Basic operators:
  - ET, OU, logic negation.
  - Schematic representation.
- Other logical operators:
  - NAND and NOR circuits
  - Or exclusive.

    - Implication.
    - Schematic representation.
- Truth table.
- Expressions and logic functions.
- Algebraic writing of a function in first and second normal form
- Expression of a logic function with NANDs or NOR circuits exclusively.
- Logical diagram of a function.
- Simplification of a logical function:
    - Algebraic method.
    - Karnaugh paintings.
    - Quine-McCluskey method.

Evaluation mode : Exam (60%) , continuous control (40%)

References

- John R. Gregg, Ones and Zeros: Understanding Boolean Algebra, Digital Circuits, and the Logic of Sets 1st Edition , Wiley & sons Inc. publishing, 1998, ISBN: 978-0-7803-3426-7.
- Bradford Henry Arnold , Logic and Boolean Algebra, Dover publication, Inc., Mineola, New York, 2011, ISBN-13: *978-0-486-48385-6*
- Alain Cazes,Joëlle Delacroix, Architecture Des Machines Et Des Systèmes Informatiques : Cours et exercices corrigés, 3° édition, Dunod 2008.

Semester : 01
Teaching unit: Methodological
Module : Scientific terminology and written and oral expression
Credits : 2
Coefficient : 1

Teaching objectives :
- Written expression techniques: learn to write a dissertation, make a report or a summary.
- Oral expression techniques: giving a presentation or a defense, learning to express yourself and communicate within a group.

Recommended prior knowledge: Knowledge of the French language

Content of the module:

Chapiter1 : Scientific Terminology
Chapiter 2 : Written and oral expression technique (report, summary, use of modern means of communication) in the form of presentations
Chapiter 3 : **Expression and communication in a group. In the form of a mini group project.**

Evaluation mode : Exam (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: Methodological
Module : English language 1
Credits : 2
Coefficient : 1

Teaching objectives:
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 specialized vocabulary of scientific and technical English.
Recommended prior knowledge: Basic knowledge of English

Content of the module:

1. **Reminders of the essential basics of English grammar**
    - Times (present, past, future, etc.)
    - Verbs: regular and irregular.
    - The adjectives.
    - The auxiliaries.
    - Construct sentences in English: affirmative, negative and interrogative, Sentence formation.
    - Other structures of English grammar.

2. **Vocabulary, expressions and construction of technical texts**
    - Computers and the internet: technical vocabulary.
    - Construction of technical texts in English**.**

Evaluation mode : Exam (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
Module : Physics 1 (Point mechanics)
Credits : 4
Coefficient : 2

Teaching objectives :

At the end of this course, the student will have to acquire basic knowledge in 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.

Recommended prior knowledge: Basic notions of Physics

Content of module :

Chapter 1: Point kinematics

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

Chapter 2: 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 3: Work and energy in the case of a material point.

a) Kinetic energy-Gravitational and elastic potential energy.
b) Force field -Non-conservative forces

Evaluation mode : Exam (60%) , continuous control (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 : 01
Teaching unit: Discovery
Module : Electronics, system components
Credits : 4
Coefficient : 2

Teaching objectives:
Present the main units of a computer and explain their operation as well as the principles of their use.

Recommended prior knowledge: General computer knowledge.

Content of module

Chapiter 1. Preamble – Definitions and Generalities
Chapiter 2. Parts of a computer
Chapiter 3. Electronic components of a computer
- 3.1. The main components of a computer and their role
  - 3.1.1. The motherboard
  - 3.1.2. The processor
  - 3.1.3. The memory
  - 3.1.4. The graphics card
  - 3.1.5. The hard drive
- 3.2. The main elements connected to the computer motherboard

Chapiter 4. The different types of devices
- 4.1. The input device
- 4.2. Output devices
- 4.3. Les Input-output devices

Chapiter 5. Connexions to computer
Chapiter 6. Operating systems
- 6.1 Definition
- 6.2 Missions
- 6.3 Types of systems
- 6.4 Elements of system
  - 6.4.1 Core: functionalities, -types, -typology of systems
  - 6.4.2 System libraries
  - 6.4.3 Systems Services

Chapiter 7. Introduction to Networks
- 7.1 The Networks :
  - 7.1.1 Areas of network use
  - 7.1.2 The internet
  - 7.1.3. Objectives
  - wanted (networks)
- 7.2. Network Categories
- 7.3. Physical and logical structuring
  - 7.3.1 Equipment
  - 7.3.2 The software
- 7.4. Types of networks
  - 7.4.1. The "Peer to Peer"
  - 7.4.2. The "Client / Server
- 7.5. Hardware
  - 7.5.1. Transportation media
  - 7.5.2. The Topologies
  - - Bus topology
  - - Star topology

- Ring topology

7.6. Software & protocoles

7.6.1. ETHERNET

7.6.2. Token Ring

7.6.3. Popular protocols

Chapiter 8. Wireless networks

8.1 Definition

8.2 Applications

8.3 Classification

Evaluation mode : Exam (60%) , continuous control (40%)

References

- T. Floyd. Electronique. Composants et systèmes d'application. 2000 Editions Dunod
- Jacques Lonchamp, Introduction aux systèmes informatiques Architectures, composants, prise en main, 2017 collection infosup, Dunod.

Semester : 02
Teaching unit: Fundamental
Module : Analysis 2
Credits : 6
Coefficient : 4

Objectives of course:

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

Recommended prior knowledge: Analysis 1.

Chapiter I : Indefinite Integrals

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

Chapiter II : Definite Integrals

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

Chapiter III : First order differential equations

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

Chapiter 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.

Evaluation mode : Exam (60%) , continuous control (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
Module : Algebra 2
Credits : 4
Coefficient : 2

Teaching objectives:
Establishment of the basic principles of vector spaces
Recommended prior knowledge: Basic algebra.

Chapiter 1 : Vectorial space.

. Definition. vector subspace.
Examples.
Familles libres. Génératrices. Bases. Dimension.
Finite-dimensional vector space (properties).
Additional vector subspace.

Chapiter2 : Linear Applications.

- Definition.
- Image and kernel of a linear application.
- Rank of an application, rank theorem.
- Composed of linear applications. Inverse of a bijective linear map, automorphism.

Chapiter 3 : Matrix.

a. Matrix associated with a linear application.
b. Matrix operations: sum, product of two matrices, transpose matrix.
c. Vector space of matrices with n rows and m columns.
d. Ring of square dies. Determinant of a square matrix and properties. Invertible matrices.
e. Rank of a matrix (associated application). Rank invariance by transposition.

Chapitre 4 : Résolution de systèmes d'équations.

1. Système d'équations – écriture matricielle - rang d'un système d'équations.
2. Méthode de Cramer.

Evaluation mode : Exam (60%) , continuouss control (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, 199

Semester : 02
Fundamental teaching unit : UEF22
Module : Algorithms and data structure 2
Credits : 6
Coefficient : 4

Teaching objectives: allow the student to acquire fundamental notions of programming
Recommended prior knowledge: Basic notions of mathematics

Content of module :

Chapter 1: Subroutines: Functions and Procedures

1. Introduction
2. Definitions
3. Local variables and global variables
4. Passing parameters
5. Recursion

Chapter 2: Files

1. Introduction
2. Definition
3. File Types
4. File handling

Chapter 3: Linked lists

1. Introduction
2. Pointers
3. Dynamic memory management
4. Linked lists
5. Operations on linked lists
6. Doubly linked lists
7. Special linked lists
    - 7.1. Batteries
    - 7.2. The lines

NB : TPs en C (Complementaires to TDs).

Evaluation mode : Exam (60%) , continuous control (40%)

References

- Thomas H. Cormen, Algorithmes Notions de base *Collection : Sciences Sup, Dunod,* 2013.
- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest Algorithmique - 3ème édition - Cours avec 957 exercices et 158 problèmes Broché, Dunod, 2010.
- Rémy Malgouyres, Rita Zrour et Fabien Feschet. *Initiation à l'algorithmique et à la programmation en C : cours avec 129 exercices corrigés*. 2ième Edition. Dunod, Paris, 2011. ISBN : 978-2-10-055703-5.
- Damien Berthet et Vincent Labatut. *Algorithmique & programmation en langage C - vol.1 : Supports de cours*. Licence. Algorithmique et Programmation, Istanbul, Turquie. 2014, pp.232.
- Damien Berthet et Vincent Labatut. *Algorithmique & programmation en langage C - vol.2 : Sujets de travaux pratiques*. Licence. Algorithmique et Programmation, Istanbul, Turquie. 2014, pp.258. <cel-01176120>
- Damien Berthet et Vincent Labatut. *Algorithmique & programmation en langage C - vol.3 : Corrigés de travaux pratiques*. Licence. Algorithmique et Programmation, Istanbul, Turquie. 2014, pp.217. <cel-01176121>
- Claude Delannoy. *Apprendre à programmer en Turbo C*. Chihab- EYROLLES, 1994.

Semester : 02
Fundamental teaching unit: UEF22
Module : Machine structure 2
Credits : 4
Coefficient : 2

Teaching objectives: At the end of the semester, students benefit from basic knowledge of computer architecture and the operating principle of each component. This knowledge will serve as a platform for other aspects related to the computer (programming, database, networks,…).

Recommended prior knowledge: Students must have basic knowledge of computer science.

Content of module :
Chapiter 1 : Introduction
Chapiter 2 : Combinatorial logic

- Definition.
- Combinatorial circuits.
- Steps in designing a combinational circuit:
  - Establishment of the truth table.
  - Simplification of logic functions.
  - Creation of the logical diagram.
- Study of some common combinatorial circuits:
  - The half adder.
  - The full adder.
  - The adder subtractor (in true complement)
  - Decoders.
  - Multiplexers.
  - Priority encoders.
  - Demultiplexers.
- Other examples of combinational circuits.

Chapiter 3 : Sequential logic.

- Definition.
- The seesaws (RS, JK, D)
- Registers (parallel loading and shift)
- The memories.
- Synthesis of a sequential circuit (automata):
  - Moore automaton and Mealy automata.
  - Transition graph and matrix.
  - Choice of flip-flops and coding of states.
  - Flip-flop excitation matrix.
  - Simplification of logic functions.
  - Establishment of the logical diagram.
- Creation of automata :
  - Counters/down counters.
  - Other examples of automata.

Chapiter 4 : Integrated circuits.

- Definition
- Study of the characteristics of a simple integrated circuit (example circuit or 7432)
- Notions on carrying out the assembly of a simple combinatorial circuit using integrated circuits.

Evaluation mode : Exam (60%) , continuous control (40%)

References

- John R. Gregg, Ones and Zeros: Understanding Boolean Algebra, Digital Circuits, and the Logic of Sets 1st Edition , Wiley & sons Inc. publishing, 1998, ISBN: 978-0-7803-3426-7.
- Bradford Henry Arnold , Logic and Boolean Algebra, Dover publication, Inc., Mineola, New York, 2011, ISBN-13: *978-0-486-48385-6*
- Alain Cazes,Joëlle Delacroix, architecture des machines et des systèmes informatiques : Cours et exercices corrigés, 3° édition, Dunod 2008.

Semester : 02
Teaching unit: Methodological
Module : Introduction to probability and descriptive statistics
Credits : 3
Coefficient : 2

Teaching objectives:
Introduce the fundamental notions of probability and statistical series with one variable and two variables.
Recommended prior knowledge: Basic mathematics.

Content of module :

Chapiter 1 : Basic notions and statistical vocabulary

- Basic concepts of statistics (Population and individual, Variable (or character))
- Statistical tables: Case of qualitative variables (Circular representation by sectors, Organ pipe representation, Bar chart), case of quantitative variables (Bar chart, Histogram, Polygon).

Chapiter 2 : Numerical representation of data

- Characteristics of central tendency or position (Median, Quartiles, Interquartile range, Mode, Arithmetic mean, Weighted arithmetic mean, Geometric mean, Harmonic mean, Quadratic mean).
- Dispersion characteristics (range, standard deviation, average absolute deviation, coefficient of variation).

Chapiter3 : Calculation of probabilities

- Combinatorial analysis: (Fundamental principle of combinatorial analysis, Arrangements, Permutations, Combinations).
- Probabilizable space: (Random experiment, Elementary and compound events, Realization of an event, Incompatible event, Complete event system, Algebra of events, Probabilizable space, Concept of probability).
- Probable space: (Definitions, consequence of the definition, conditional probability, independent events, independent experiments)
- Construction of a probability
- Conditional probabilities, independence and compound probabilities (Conditional probabilities, Independence, Mutual independence, Compound probabilities, Bayes formula).

Evaluation mode : Exam (60%) , continuous control (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: Methodological
Module : Information and communication technology
Credits : 2
Coefficient : 1
Content of module :
Teaching objectives: Familiarization with computer science tools and the Internet.

Recommended prior knowledge: General computer science knowledge.

Content of module :

Chapiter 1 : The TIC : tools and applications

a. definition
b. tools of TIC :
   i. computers
   ii. softwares
   iii. communications networks
   iv. smart chips
c. applications of TICs
   i. communications spaces: Internet, Intranet, Extranet
   ii. databases
   iii. multimedia: Audioconferencing, videoconferencing
   iv. electronic data interchange (EDI)
   v. the workflows

Chapiter 2 Introduction to web technology

2.1 Presentation of the internet
- 2.1.1 Definition
- 2.1.2 Applications
- 2.1.3 Terminologies

2.2 Searching the web
- 2.2.1 Search tools
  - 2.2.1.1 search engines
  - 2.2.1.2 directories
  - 2.2.1.3 automatic indexing
  - 2.2.1.4 browsers
- 2.2.2 Search refinement
  - 2.2.2.1 choice of keywords
  - 2.2.2.2 boolean operators
  - 2.2.2.3 adjacency, truncation
- 2.2.3 queries by fields, advanced search
- 2.2.4 Other search tools

Chapiter 3 : the contributions of NICTs to external communication

3.1 Advertising on the Internet
- 3.1. 1. Banners
- 3.1.2. Interstitials
- 3.1.3. The Windows

3.2 Online site promotion:
- 3.2.1 The sponsoring
- 3.2.2. The electronic community
- 3.2.3. The'e-mailing

3.3 The security of an online payment system
- 3.3.1. Encryption

3.3.2. Website data protection

Evaluation mode : Exam (100%)

References

- Collectif Eni **,** Microsoft Office 2016Word, Excel, PowerPoint, Outlook 2016 - Fonctions de base**,** Eni Collection : Référence bureautique,2016
- Dan Gookin, Greg Harvey, Word et Excel 2016 pour les nuls, First, Collection : Pour les nuls - Poche (informatique), 2016
- Myriam GRIS, Initiation à Internet, Eni editions, 2009

Semester : 02
Teaching unit: Methodological
Module : Programming Tools for Mathematics
Credits : 2
Coefficient : 1

Teaching objectives: Mastery of scientific software.
Recommended prior knowledge: Basic programming

Content of the subject:

Chapter 1: Mastery of Software (Matlab, Scilab, Mathematica, etc.)
Chapter 2: Examples of applications and resolution techniques

Evaluation mode : Exam (60%) , continuous control (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 : 02
Teaching unit: Transversal
Module : Physics 2 (general Electricity)
Credits : 3
Coefficient : 2

Teaching objectives:
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 linked to it.
Recommended prior knowledge: Basic notions of Physics

Content of module:

Chapter 1: Electrostatics

- Electrostatic forces
- Fields
- Potential
- Electric dipole
- Gauss's theorem

Chapter 2: Drivers

- Total and partial influence
- Calculation of capacities – Resistances – Laws
- Generalized Ohm's law

Chapter 3: Electrokinetics

- Ohm's law
- Kirchoff's law
- Thévenin's law - Norton

Chapter 4: Magnetostatics

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

Evaluation mode: Exam (60%) , continuous control (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
Module : Algebra 3
Credits : 5
Coefficient : 3

Teaching objectives:
Acquire the fundamental elements of algebra, namely vector spaces, multilinear algebra and the reduction of endomorphisms.
Recommended prior knowledge: Basic algebra

Content of module :

Chapiter 1 : Reminder Construction of the ring of polynomials

Chapiter 2 : Reduction of endomorphisms of finite-dimensional vector spaces.

- values and eigenvectors; characteristic polynomial, Cayley-Hamilton theorem
- diagonalization of diagonalizable matrices, trigonalization, Jordan forms.
- Change of bases

Chapiter 3 Exponential of a matrix and Application to linear differential systems.

Evaluation mode : Exam (60%) , continuous control (40%)

References

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

Semester: 03
Teaching unit: Fundamental
Subject: Analysis 3
Credits: 7
Coefficient: 4
Teaching objectives:

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.

Recommended prior knowledge: Analysis 1 and Analysis 1
Content of the material:

Chapter 1: **Digital Series**

Series with real or complex terms, Algebraic structure of the set of convergent series, Cauchy criterion, Series with positive terms, Comparison theorems, Riemann series, Rule of d'Alembert, Rule of Cauchy, Rule of Cauchy-Maclaurin of the integral, Bertrand series, Series in terms of any signs, Leibniz series, Alternating series, Rule of convergence of alternating series, Rules of convergence of series in terms of any signs, Dirichlet rule, Abel's rule, Properties additional convergent series, Grouping of terms, Product of series.

Chapter 2: 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 3: Entire 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 4: 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 5: 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, Cauchy's principal value, Generalized integral of an unbounded function , Change of variable in an improper integral, Generalized integral and series, Average formulas, Second average theorem, Practical methods for calculating certain generalized integrals.

Chapter 6: Functions defined by an integral

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

Evaluation 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
Subject: Introduction to Topology
Credits: 6
Coefficient: 3
Teaching objectives:
Its objective is to provide the basics in topology essential to any training in mathematics.
Recommended prior knowledge: Set techniques, Elementary analysis on the real line R: The field of reals defined as an Archimedean body containing Q and verifying the property of the upper bound, real sequences, intervals, continuous functions of R in R, differentiation, algebra linear and bilinear, vector spaces, bases, linear applications, matrix calculation, determinants, scalar product, functions of several variables, partial derivatives.
Content of the material:
Chapter 1: Topological spaces

- Open, neighborhood, base 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 2: 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 3: Complete spaces

- Cauchy suites
- Completeness
- Prolongation of a uniformly continuous application
- Fixed points of contractions

Chapter 4: Related spaces

- Connectedness
- Locally related spaces

Chapter 5: Normed vector spaces

- Standards
- Distance associated with a standard
- Equivalent standards

Evaluation 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: Methodological
Subject: Numerical analysis 1
Credits: 4
Coefficient: 3
Teaching objectives:
Introduction to numerical calculation, presentation of some methods for the approximation of functions.
Recommended prior knowledge
Mathematical analysis (Analysis 1,2 and 3).
Content of the material:

Chapter 1: Concepts of errors

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

Chapter 2: Solving an algebraic equation

Dichotomy (bisection) method - Fixed point method - Newton-Raphson method - Estimation of errors.

Chapter 3: Interpolation and Approximation

Lagrange method - Newton method - Interpolation errors - Least squares approximation.

Chapter 4: Numerical derivation. Chapter 5: Digital integration

Newton-Cotes formula - Trapezoid method - Simpson method - Quadrature errors.

Evaluation 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.
- Ph. G. Ciarlet : Introduction à l'analyse numérique matricielle et à l'optimisation, Dunod, Paris 1998.
- Curtis F. Gerald, P. O. Wheatdey : Applied Numerical Analysis, Addison-Wesley Pub. Compagny.
- P. Lascaux, R. Theodor : Analyse numérique matricielle appliquée à l'art d'ingénieur, Tomes I et II, Masson, Paris.
- G. Meurant : Résolution numérique des grands systèmes, Ed. Stanford University.
- P. Lascaux, R. Theodor : Analyse numérique matricielle appliquée à l'art d'ingénieur Tomes I et II, Masson, Paris.

Semester: 03
Teaching unit: Methodological
Subject: Mathematical logic
Credits: 3
Coefficient: 2
Teaching objectives:
Acquire the foundations of mathematical reasoning, Acquire the foundations of set theory and acquire the elements of writing mathematical proofs.

Prior knowledge: Algebra1

Content of the material:

Chapter 1: 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 2: Set theory

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

Chapter 3: 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, Rule of Modus Ponens. Modus Tollens rule.
Calculation of predicates, Universal and existential quantifier, The quantifier of unique existence. 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 4: Good order and proof by induction

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

Evaluation 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: Methodological
Subject: Programming Tools 2
Credits: 3
Coefficient: 1

Teaching objectives:

Recommended prior knowledge

Content of the material:

Chapter 1: Getting Started

Start-up and variable help – Variables – Working directory – Saving the working environment – Functions and commands.

Chapter 2: Numbers in Matlab with license or Scilab

Natural numbers - Representation of real numbers - Complex numbers.

Chapter 3: Vectors and Matrices

Operations on vectors and Matrices - Elementary mathematical functions.

Chapter 4: Programming elements

Script – Function – Control loop – Conditional instruction.

Chapter 5: Polynomials

Polynomials in Matlab with license or Scilab - Zeros of a polynomial - Operations on polynomials.

Chapter 6: Graphics in Matlab with license or Scilab

Display of curves in dimension two and dimension three - Graph of a function - Analytical Surface.

Chapter 7: Symbolic calculation

Calling the symbolic toolbox - Development and implementation of an expression - Derivative and primitive of a function - Calculation of the limited development of a function.

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

References

- Calcul scientifique avec Matlab, Jonas-Koko, Ellipses.
- Introduction au Matlab, J. T. Lapresté, Ellipses.

Semester: 03
Teaching unit: Discovery
Subject: History of Mathematics
Credits: 2
Coefficient: 1

Teaching objectives: Understand civilizations and the evolution of the mathematical mind through the ages.
Connaissances préalables recommandées : Culture générale et scientifique

Content of the material:

Chapter 1: Introduction.

Chapter 2: 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 the Muslim West.

Chapter 7: The transmission of mathematical knowledge to Europe.

Chapter 8: The renaissance in Europe.

Chapter 9: The industrial revolution and its consequences.

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

Chapter 11: The 20th century and the expansion of the scope.

Evaluation method: Exam (100%)

References :

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

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

Teaching objectives: The objective of this module is to provide the necessary knowledge concerning the differentiability of a function of several variables, the generalizations of the finite increase theorems and the Taylor formula to functions of several variables, the calculation of extrema as well as the calculation of multiple integrals.
Recommended prior knowledge: Analysis 1 and Analysis 2

Content of the material:
Chapter 1: Topology of IRn.

Concept of norm, Open set, Open parts, Neighborhood, Closed and compact parts in IRn.

Chapter 2: Functions of multiple variables

Limit of a function, Continuous function, Partial derivatives along a vector, Differentiable functions, Derivative of a compound function, Gradient, Differential of a function, Higher order differential, Schwarz's Lemma, Taylor's formula, Extrema, Case functions of two variables, Calculation of the minimum and maximum of a function, Linked extremum, Theorem of implicit functions.

Chapter 3: Multiple Integrals

Iterated integrals, Definition of the double integral on a rectangle, Fubini's theorem on a rectangle, Double integral on a bounded domain D, General properties of the double integral, Change of variable in a double integral, Transition to 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, Change to cylindrical, Change to spherical. Applications: Calculation of volumes, surfaces.

Evaluation 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
Subject: Algebra 4
Credits: 5
Coefficient: 3

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

Recommended prior knowledge: Algebra 1 2 and 3; Analysis 1, 2, 3 and 4

Content of the material:

Chapter 1: Linear forms – Duality (vector space and its dual)

Chapter 2: Bilinear forms on a vector space

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

Chapter3: Spectral decomposition of a self-adjoint linear map

Chapter 4: Symmetric bilinear form and quadratic form

Gaussian decomposition (Sylvester's theorem)

Chapter 5: Introduction to Hermitian space

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

References

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

Semester: 04

Teaching unit: Fundamental

Subject: Complex analysis

Credits: 6

Coefficient: 3

Teaching objectives:

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).

Recommended prior knowledge: Analysis L1, L2.

Content of the material:

Chapter 1: Topology in the complex plane.

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

Chapter 2: Function of the complex variable

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

Chapter 3: Basic functions

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

Chapter 4: 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 5: Development in Taylor series and Laurent series

- 1-Development in Taylor series.
- 2- Laurent series development
- 3-Singularity isolated from a complex function.

Chapter 6: Residue theorem and its applications

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

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

References:

1- M. Lavrentiev, B. Chabat, Méthode de la théorie des fonctions d'une variable complexe, Edition Mir, Moscou, 1977.

2- V. Smirnov, Cours de Mathématiques Supérieures, Tome 3, OPU 1985.

3- W. Rudin, Analyse réelle et complexe, Cours et exercices 1987.

4- John B. Conway, Functions of one complex variable, Springer-Verlag, New York 1978. 5-

5- B. Belaidi, Analyse Complexe Cours et Exercices Corrigés, 2002, 245 p. (En langue arabe). Deuxième édition 2009

Semester: 04
Teaching unit: Methodological
Subject: Numerical Analysis 2
Credits: 4
Coefficient: 2

Teaching objectives: Learn the basis of matrix analysis and applications to the resolution of Linear systems.

Recommended prior knowledge: Linear algebra and matrix calculus.

Content of the material:

Chapter 1: Solving linear systems

Call for notions of linear algebra - Direct methods (Gauss methods - LU decomposition - Cholesky method) - Iterative methods (Problem position - Jacobi method - Gauss-Seidel method - Relaxation method - Convergence of iterative methods) - Estimation of errors.

Chapter 2: Calculation of eigenvalues and vectors

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

Chapter 3: Numerical resolution of order one ODEs

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

Chapter 4: Solving nonlinear algebraic systems.

Evaluation 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.
- Ph. G. Ciarlet : Introduction à l'analyse numérique matricielle et à l'optimisation, Dunod, Paris 1998.
- Curtis F. Gerald, P. O. Wheatdey : Applied Numerical Analysis, Addison-Wesley Pub. Compagny.
- P. Lascaux, R. Theodor : Analyse numérique matricielle appliquée à l'art d'ingénieur, Tomes I et II, Masson, Paris.
- G. Meurant : Résolution numérique des grands systèmes, Ed. Stanford University.
- P. Lascaux, R. Theodor : Analyse numérique matricielle appliquée à l'art d'ingénieur Tomes I et II, Masson, Paris.

Semester: 04
Teaching unit: Methodological
Subject: Probability
Credits: 3
Coefficient: 2

Teaching objectives:
This subject aims to familiarize the student with the concepts and elementary techniques of probability.
Recommended prior knowledge: Basic notions of probability

Content of the material:

Chapter1: Random variables

One-dimensional random variables: General – Distribution function. Discrete random variables – law of probability - Expectation - Variance. Absolutely continuous random variables - Density function - Expectation -Variance.

Probability inequalities (Markov, Jensen, Chebyshev, etc.)

Chapter 2: 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-Beta, Chi-square, Student, Fisher,…
- Approximations of certain laws
    - o Approximation of a hypergeometric law by a binomial law
    - o Approximation of a binomial distribution by a Poisson distribution
    - o Approximation of a Poisson distribution by a normal distribution
    - o Approximation of a binomial distribution by a normal distribution.
- Transformations on random variables

Evaluation 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: Methodological
Subject: Geometry
Credits: 3
Coefficient: 2

Teaching objectives:
Acquire the basics of affine geometry and Euclidean geometry. Master the geometry of parametric curves.
Recommended prior knowledge
Algebra1 and Algebra2. Analysis1 and Analysis2. Vector functions.

Content of the material:
Chapter 1: Affine geometry

- Definition of an affine space
- Concept of barycenter
- Affine varieties affine applications and affine forms
- Lines and Hyperplanes
- Translation, homotheties, symmetry.

Chapter 2: Euclidean affine space

- Euclidean space structure, norm and angle, Gram-Schmidt orthonormalization
- Orthogonal subspaces (hyperplane orthogonal to a line, distance from a point to a line….)
- Applications in Euclidean affine spaces: isometry and similarity.

Chapter 3: Parameterization of curves and surfaces

- Parameterized curve: General
- Local study of plane curves
- Local study of left curves
- Plot of plane parameterized curves: 1) Curves in Cartesian coordinates
  2) Curves in polar coordinates
- Examples of curves and surfaces

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

Reference :

- Cours de Géométrie Affine et Euclidienne pour la Licence de Mathématiques, Emmanuel Pedon, Universit´e 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
Subject: Application of mathematics to other sciences
Credits: 2
Coefficient: 1

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

Recommended prior knowledge: Good basics in mathematics and their applications.

Content of the material:

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

For example :

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

Evaluation method: Exam (100%)

Semester:5
Teaching unit: Fundamental
Subject: Measurement and Integration
Credits: 6
Coefficient: 4
Teaching objectives: To introduce the student to a new theory which is the theory of measurement as well as its application to probabilities, placing him in a new context of spaces which are the spaces measured, consequently a broad theory on integration is defined, in particular that of Lebesgue allowing him to become familiar with the major results of integration such as Lebesgue's dominated convergence theorem and Fubini's theorems.
Recommended prior knowledge: Algebra 1 and 2, Topology
Content of the material:
Chapter 1: Tribes and measures

- Reminders on set theory.
- Algebras and tribes.
- Positive measures, probability.
- Properties of measurements, external measurements, complete measurements
- Lebesgue's measure on the Borelian tribe

Chapter 2: Measurable functions, random variables

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

Chapter 3: Integrable Functions

- Integral of a positive stepped function.
- Integral of a positive measurable function.
- Integral of a measurable function.
- Comparison of the Lebesgue integral with the ‘iemann integral
- Measurement and probability density
- Monotonic convergence and Fatou’s lemma
- The L1 space of integrable functions
- Dominated convergence theorem in L1
- Continuity and differentiability under the sum sign

Chapter 4: Product of measured spaces

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

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

- T. Galay, Théorie de la mesure et de l’intégration, Université Joseph Fourier, Grenoble(2009), en pdf.
- M. Beguin, Introduction à la théorie de la mesure et de l’intégration pour les probabilités, Ellipse(2013).
- A Giroux. Initiation à la mesure et à l’intégration, ellipse(2015).
- N. Boccara, Intégration, ellipses, 1995.
- Hadj El Amri, Mesures et intégration.
- Roger Jean, Mesures et intégration.
- O. Arino, Mesures et intégration (exercices).

Semester:5
Teaching unit: Fundamental
Subject: ***Normed vector spaces***
Credits: 5
Coefficient: 3
Teaching objectives:
Teach students the importance of Banach space and the particularity of Hilbert space as a class of normalized spaces. Show results specific to this space.
Recommended prior knowledge: Analysis1, analysis2, analysis3, topology

Content of the material:
Chapter 1: Banach Space

- Norms, equivalent norms, Banach space
- Properties of the standard, ….
- Examples of Banach spaces
- Normalized finite-dimensional vector spaces
- Continuous linear applications: Definitions, standard of a continuous linear application
- Dual of a normalized vector space

Chapter 2: Hilbert space

- Dot product, pre-Hilbertian space, Hilbert space
- Properties of the scalar product, Cauchy-Schwarz inequality, equality of the parallelogram, etc.
- Orthogonality, projection theorem, Riesz theorem
- Orthogonal system (Bessel-Parseval inequality), base
- Orthonormal systems
- Fourier series
- Complete orthonormal systems in concrete spaces

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

References:

- Brezis H. Functional Analysis, Theory and Applications
- Lacombe G., Massat P. Functional Analysis. Corrected exercises, DUNOT
- ‘iesz F., Nagy B. Sz Lessons in functional analysis
- Sonntag Y. Topology and Functional Analysis, Courses and exercises, Ellipses, 1997, Gauthier&Villars

Semester:5
Teaching unit: Fundamental
Subject: Differential equations
Credits: 6
Coefficient: 4
Teaching objectives:
This subject teaches the fundamental notions and theorems allowing the qualitative study of ordinary differential equations.
Recommended prior knowledge: Real Analysis and Linear Algebra, topology
Content of the material:

Chapter 1: 1st order equations

- Fundamental results
- Local and global existence, uniqueness
- Dependence on initial conditions.

Chapter2: Higher order equations-1st order systems

Chapter3: Linear systems

- Matrix exponential
- Systems with second order
- Resolving

Chapter4: Introduction to the notions of stability.

Evaluation 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:5
Teaching unit: Fundamental
Subject: Mathematical physics equation
Credits: 5
Coefficient:2
Teaching objectives
This course is supposed to provide the mathematical tools used in technical sciences (mechanics, electrical engineering, geophysics, etc.)
Recommended prior knowledge: Real Analysis and Linear Algebra, topology

Content of the material:

Chapter1: Order PDE1-Characteristics Methods

- Linear case
- Quasi-linear case
- Nonlinear case

Chapter2: Second order linear PDEs, characteristics, classification, standard forms.
Chapter 3: Variable separation method (Fourier).
Chapter 4: Laplace equation, harmonic functions, Poisson kernel.
Chapter 5: Wave equations (Kirchhoff formula).
Chapter 6: Heat equation (Poisson integral).

Evaluation 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:5
Teaching unit: Methodology
Subject: Optimization without constraints
Credits: 5
Coefficient:2
Teaching objectives
The module offers 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 using the scientific calculation software Matlab, in order to assimilate the theoretical notions of algorithms seen in class.
Recommended prior knowledge: Basic notions of differential calculus in R^n.
Content of the material:
Chapter 1: Some reminders of differential calculus, Convexity

- Differentiability, gradient, Hessian matrix
- Taylor development
- Convex functions

Chapter2: Minimization without constraints

- Existence and uniqueness results
- First order optimality conditions
- 2^{nd} order optimality conditions

Chapter3: Algorithms

- Gradient method
- Conjugate gradient method
- Newton's method
- Relaxation method
- Practical work

Evaluation 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:5
Teaching unit: Discovery
Subject: Introduction to mathematics didactic
Credits: 3
Coefficient:1
Teaching objectives
This program contains three components which are: the introduction, the didactic program and some reference. The introduction contains the educational guidelines. The program contains the hourly volume, the expected results (end of the year) and the content.
Recommended prior knowledge: Minimum academic background
Content of the material:
1/ Why mathematics teaching?

- 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, formation of notions
- mathematics, epistemological characteristics and didactic questioning).
- Epistemology, representations and relationship to knowledge.
- Historical evolution for some mathematical concepts (numbers, types of geometry, etc.).

3/How do students learn?
Genetic and didactic epistemology:

- Conceptions of learning (traditional theory, behaviorism, constructivism).
- Some trends in cognitive psychology (the theories behaviorism, cognitivism and epistemology genetic).

4/Directed work

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

Evaluation mode : Examen (100%)

References:

- M. Henry (1991), Didactique Des Mathématiques, Irem De Besançon.
- Y. Chevallard & M. A. Johsua (1991), La Transposition Didactique, La Pensée Sauvage.
- Y. Chevallard (1982), Sur L'ingénierie Didactique, L'irem D'aix-Marseille.
- 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:6
Teaching unit: Fundamental
Subject: Introduction to group theory
Credits: 9
Coefficient:5

Teaching objectives
This module introduces fundamental notions for group theory, group structure is useful for understanding bodies and linear codes as well as their applications.
Recommended prior knowledge: Algebra1 and Algebra2

Content of the material:
Chapter 1: Groups and morphisms
Group, subgroup, equivalence classes modulo a subgroup, Lagrange theorem, morphism of groups, image, kernel, isomorphism, distinguished group, quotient group, isomorphism theorem, cyclic group, Euler indicator, under -groups of a cyclic group, study of groups Z / nZ and (Z /nZ)*.
Chapter2: Action of a group on a set.
Definition of the action of a group, orbit, stabilizer, fixed point, Burnside theorem,
Chapter 3: Finite abelian groups

- Structure of finite abelian groups
- Applications

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

References:

- Algèbre pour la licence 3 (groupes, anneaux et corps). Auteurs : Jean Jaques Risier, Pascal Boyer.Dunod Paris 2006. ISBN 210 049498 8.
- Algèbre et géométrie. Auteurs : Jean Delcourt, Remit Goblot. Dunod Paris 2005. ISBN 210 0453358.
- D. J. S. 'obinson, '' A course in the theory of groups'', 2nded, Springer-Verlag, New York, 1995.

Semester:6
Teaching unit: Fundamental
Subject: Theory of bodies
Credits: 9
Coefficient:5

Teaching objectives
This teaching should allow the student to acquire the elementary knowledge provided by the theory of bodies, on the other hand, the student will be able to familiarize themselves with useful tools for example for the study of linear codes and cryptography...
Recommended prior knowledge: Algebra1

Content of the material:

Chapter 1: Rings and morphisms.
Ring, subring, ideal, ring morphism, quotient ring, prime ideal, maximal ideal, invertible elements, associated elements, irreducible elements, prime elements, main ring, Euclidean ring, factorial ring.

Chapter 2: Body
Definitions, examples, characteristics, prime bodies.

Chapter 3: Construction of finite bodies
Cardinal of a finite field, irreducible polynomial, practical construction of a finite field.

Chapter 4: Applications
Examples of applications in linear codes, cryptography, etc.

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

References:

- E. Ramis, C. Deschamps, et J. Odoux. Cours de Mathématiques 1, Algèbre. Dunod, 1998.
- Rudolf Lid land HaraldNiederreiter, Finite fields, Encyclopedia of Mathematics and applications, Cambridge university press, 1997.
- M. Demazure. Cours d'algèbre. Primalité, divisibilité, codes. Cassini. 1997.

Semester:6
Teaching unit: Fundamental
Subject: Inferential Statistics
Credits: 9
Coefficient:5
Teaching objectives
This subject teaches the fundamental notions and theorems of classical inferential statistics.
Recommended prior knowledge: Analysis, probabilities
To follow this course, the student must master the methods of analysis and basic algebra as well as the essential techniques of calculating probabilities.
Content of the material:

Chapter 1: Sampling

Sample Concepts
Sample Statistics: Empirical Mean, Empirical Variance
Gaussian samples

Chapter 1: Point Estimation

o Estimator construction methods

- Moment Method
- Maximum likelihood method

o Characteristics of an estimator:

- Bias, Root Mean Square Deviation, Convergence
- Amount of information from Fisher,
- Cramer Rao Bollard
- Efficiency
- Exhaustiveness

Chapter 2: Estimation by Confidence Intervals

o Problematic and definition
o Gaussian sample

- Mean confidence interval
- Variance confidence interval

o Confidence interval of a proportion

Chapter 3: Hypothesis Testing

o Introduction: the mechanisms of a hypothesis test.
o Problematic

- The different types of errors
- The power of a test
- Decision rules (critical region)
- Concept of p-value

o Parametric testing

- One-sided testing and Bilateral Testing
- Neyman-Pearson method
- Likelihood ratio test

Chapter 4: Common Tests

o Tests on the mean of a normal distribution
o Test on the variance of a normal distribution
o Test on a proportion
o Mean comparison tests
o Proportion comparison tests

o Chi-square independence test

Method of assessment: Examination (60%), continuous assessment (40%)

References :

- Michel Lejeune. Statistique, La théorie et ses applications. Springer-Verlag France, Paris, 2010
- Renée Veysseyre. Statistique et probabilités. Dunod, Paris, 2001, 2006
- Jun Shao. Mathematical Statistics: Exercises and Solutions. 2005 Springer Science+Business Media,Inc.
- Gilbert Saporta, Probabilities, Analyse des données et Statistique, Technip, 2006.

Eva Cantoni, Philipe Huber et Elvezion ‘onchetti, Maitriser l’aléatoire, exercices de probabilités et statistique,
Springer, 2006.

Semester:6
Teaching unit: Fundamental
Subject: Advanced probabilities
Credits: 9
Coefficient:5

Teaching objectives
This course presents in detail the main concepts and methods of probability calculation (probability of events, law and moments of random variables, conditioning and regressions, transforms of random variables, Gaussian laws).
Recommended prior knowledge: Analysis1, analysis2, analysis3, Probability 1
Basic principles of real analysis and algebra.

Content of the material:
Chapter 1: Fundamental reminders of random variables

- Numerical characteristics (expectation, variance, etc.)
- Laws of probability
- Random variables and main laws of probability
- Operations on random variables

Chapter 2 : Characteristic and generating functions

- Moment generating function-
- Generating functions of the usual discrete and continuous laws
- Characteristic function
- Properties of characteristic functions
- Characteristic functions of usual laws

Chapter 3: Modes of convergence

- Different types of convergence
- Links between different types of convergence

Chapter 4: Limit Theorems

- Weak law of large numbers
- Strong law of large numbers
- Central Limit Theorem

Chapter 5: Random Vectors

- Probability law of a random vector
- Numerical characteristics (expectation, covariance variance matrix, etc.)
- Generating and characteristic function
- Conditional expectation
- Vector probability laws: the normal law in Rn.
- Convergences and central limit theorem in the vector case

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

- Rabi Bhattacharya and Edward C. Waymire. , A Basic Course in Probability Theory. 2007 Springer Science+Business Media, Inc.
- Anirban DasGupta, Fundamentals of Probability: A First Course. Springer Science+Business Media, LLC 2010
- Géza Schay, Introduction to Probability with Statistical Applications. 2007, Birkhäuser Boston

- Chung, K.L. First course in Probability theory, Markov Chains, Springer-Verlag, Berlin.

Semester:6
Teaching unit: Fundamental
Subject: : Introduction to random processes
Credits: 9
Coefficient:5

Teaching objectives:
Present the main classes of time-dependent random phenomena which occur in operational research as well as in statistics and stochastic computing and thus show the variety of applications of random processes.
Recommended prior knowledge:
The student must master the basic theory of probability calculus and integral calculus.

Content of the material:
Chapter 1: Classification of General Random Processes
Notion of Random Process, Stationary processes (strictly stationary, weakly stationary, with stationary increases), Processes with independent increases, Recurrent processes, Notion of ergodicity, Dependency relationship. Examples of Gaussian processes.

Chapter 2: Markov Chains
Markovian processes. Discrete-time Markov chain, Transition matrix and transition graph, Fundamental properties, Probability of transition in n steps, Asymptotic behavior, Transient and steady state, Stationary distribution, Stationary distribution and limit distribution, Absorbing Markov chains, Delays absorption and probability of absorption, Time to reach and probability of attack

Chapter 3: Poisson Process
Random processes in continuous time, Counting processes, Transition graph, Poisson process and exponential law, Intervals between two events, Generalization, New characterizations of the Poisson process, Superposition and Decomposition, Poisson process and uniform law, Composite Poisson process

Chapter 4: Birth and Death Process
Pure Birth Process, explosive phenomenon, Examples, Postulates of the Birth Process and death, Waiting time, Differential equations in the processes of birth and death

Chapter 5: Renewal Process
Definition, examples and general results, Asymptotic behavior of Renewal processes, Renewal processes with delay.

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

- D. Foata, A. Fuchs, Processus Stochastiques, Dunod, 2004
- Karlyn,S and H. Taylor, A First Course in Stochastic Process, San Diego, 1975
- Grimmett, C; Stirzaker, D, Probability and Random Process, Oxford University Press, third edition,Oxford, 2001
- Ross, S. Introduction to Probability Models, Academic Press, seventh edition, San Diego, 2000.

Semester:6
Teaching unit: Fundamental
Subject: : Numerical methods for ODE and PDE
Credits: 9
Coefficient:5

Teaching objectives:
This course is a succinct introduction to certain methods of Numerical Analysis, in particular the finite differences used in solving ordinary differential and partial differential equations.

Recommended prior knowledge: Undergraduate Linear Algebra, E.D.O and E.D.P.
Content of the material:

Part1: Numerical method for ODE
Chapter 1: Reminders on the different existence theorems, motivation
Chapter2: finite differences

- Principle - order of precision
- Index rating
- Simple 1D example with Dirichlet conditions
- Simple 1D example with mixed Dirichlet-Neumann conditions

Part 2 :
Chapter3: Numerical method for EDP

- Finite differences
- Higher order scheme
- Discretization of the 1D heat equation
- Explicit schema
- Implicit schema
- Crank-Nicolson scheme
- Discretization of the stationary 2D Laplace equation

Chapter4: Introduction to finite elements

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

- P.G. Ciarlet, Introduction à l'analyse numérique et à l'optimisation, Masson 1982.
- Curtis F. Gerald, Patrick O. Wheatley, AppliedNumericalAnalysis. Third Edition, Addison-WesleyPublishingCompany.
- QuarteroniA.,SaccoR.,and Saleri F.Numericalmathematics. Springer, 2000.
- J.RappazandM.Picasso - Introduction à l'analyse numérique. Presses Polytechniques et Universitaires, Romandes, Lausanne, 1998.
- P.A.'aviartandJMThomas. Introduction à l'analyse numérique des équations aux dérivées partielles

Semester:6
Teaching unit: Fundamental
Subject: : : Introduction to the theory of linear operators
Credits: 9
Coefficient:5

Teaching objectives:
Familiarize the student with the basic notions of the theory of linear operators to form a basis for possible future studies in PDE, spectral theory and abstract differential equations Recommended prior knowledge: Topology of metric spaces, normalized vector spaces and analysis Hilbertian

Content of the material:
Chapter 1: Linear operators

- Reminders on Banach spaces: Definitions and preliminary results, examples of spaces of Banach of infinite dimension, normalized 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 uniform bound
- Invertibility of linear operators

Chapter 2: Linear operators and applications

- Dual of a normalized 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 3: Introduction to the spectral theory of compact operators

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

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

References:

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

Semester:6
Teaching unit: Fundamental
Subject: Partial differential equations
Credits: 9
Coefficient:5

Teaching objectives:
Making contact with the EDPs and some of the methods and issues related to them,
learn some solving techniques of each type.
Recommended prior knowledge: Analysis, algebra, topology

Content of the material:

Chapter1: Elliptical case

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

Chapter2: Hyperbolic case – Wave equations

- By separation of variables
- Solution representation
- Huygens principle (n=1, n=2)
- Vibrating strings and plates (Fourier series)

Chapter3: Parabolic case – Heat equation

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

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

References:

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

Semester:6
Teaching unit: Fundamental
Subject: Mathematical modeling of the rhythms of life
Credits: 9
Coefficient:5

Teaching objectives:
Provide all students with an interdisciplinary culture on the modeling of complex systems, the key stages of modeling, from the formalization of the biological problem to the interpretation of the results through the mathematical analysis of the model.
Recommended prior knowledge:
The student must have knowledge of real analysis and ordinary differential equations. Equation to partial derivatives.
Content of the material:

Chapter 1: Generalities, complexity of the real world and the living world.
Modeling methodology,
Chapter2: Single-species models

- Malthus model (1798). Verhulst's logistic growth model (1836).
- Gompertz model. Growth model with “Allee” effect
- Verhulst model with predation. The Fisher equation (1937).

Chapter3: Two-species model

- 3.1Lotka-Volterra model (1926).
- 3.2 Adimensionalized system.
- Properties.
- More realistic extensions (different response functions).
- A class of models.
- A predator-prey model with dispersal.

Chapter 4: Epidemiological Models (SI,SIS,SIRS,SEIRS…)
Chapter5: Spatialization and time scales

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

- P. Auger,C, Lett, J.C. Poggiale. Modélisation mathématique en écologie. Cours et exercice
- corrigésDunod. 2010.
- J. Istas, Introduction aux modélisations mathématiques pour les sciences du vivant,
- Mathématiques & Applications 34, 2000.
- O. Diekmann and J.A .P Heesterbeek, Mathematical epidemiology of infectious diseases,
- Wiley Series in Mathematicaland Computational Biology, John & Sons Ltd, Chichester, 2000.
- L. Edelstein-Keshet, Mathematical models in biology, The Random House, Birkhauser
- Mathematics Series, Random House Inc., New York 1988.
- J. Murray: Mathematical Biology. Springer. 2001.
- Hal L. Smith, H. R. Thieme: Dynamical systems and population persistence, AMS, 2011.
- F. Brauer, C. C. Chavez : Mathematical Models in population biology and epidemiology,
- Springer. Second edition 2012.

Semester:6
Teaching unit: Fundamental
Subject: Optimization with constraints
Credits: 9
Coefficient:5

Teaching objectives:
The object of this course is an extension of optimization without constraints. We model certain problems there practices from various economic, medical, etc. activities.
For these different problems with constraints, we study the optimality conditions and we introduce the main algorithms adapted to each situation.
Recommended prior knowledge: Optimization I.
Content of the material:
Chapter1: Minimization with constraints

- 'result of existence and uniqueness
- First order optimality condition
  - Optimality condition of the first general order
  - Equality constraints
  - Constraint in equality and inequality
- Necessary 2nd order optimality conditions

Chapter2: Applications and examples

- Projection onto a closed convex
- Linear regression with constraints
- Case of linear programming
- Examples

Chapter 3: Algorithms

- Projected gradient method
- Lagrange-Newton method for equality constraints
- Projected Newton method for bound constraints
- Penalization methods
- Successive quadratic programming (S.Q.P) methods
  - Case of equality constraints
  - Case of general constraints
- Duality method: U)AWA method

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

Bibliographic references:

- E.G. Goldstein, Theory of Convex Programming, Published by American Mathematical Society
- M. Minoux, Programmation mathématique : théorie et algorithmes : tome 2, Dunod,Paris (1983)
- M. Minoux : "Programmation Mathématique. Théorie et Algorithmes", 2 (ed.), (Lavoisier),(ISBN: 978-2-7430-1000-3) (2008)
- A.W.Robert and D.E.Varberg, Convex Functions, Academic Press, New York, 1980.

Semester:6
Teaching unit: Fundamental
Subject: Linear programming
Credits: 9
Coefficient:5

Teaching objectives:
The objectives of this module are to make the student aware of the practical importance of linear optimization problems, to master the underlying theoretical set, and to be able to use these techniques in practical problems.
Recommended prior knowledge: General mathematics and computer science

Content of the material:
Chapter 1: General introduction

- History of linear programming
- Examples of modeling practical problems in the form of a linear program.

Chapter2: Geometry of linear programming

- 2.1 Vector spaces, matrix rank, systems of linear equations
- 2.2 Convex set, hyperplane, polyhedron, simplex, extreme point

Chapter 3: Primal method for solving a linear program

- Problem position
- Characterization of extreme points
- Optimality at an extreme point
- Optimality criteria: formula for increasing the objective function, optimality criterion, 3.5 sufficient condition for the existence of an unbounded solution
- Simplex algorithm: improvement of the objective function by passing from one extreme bridge to another, simplex algorithm in matrix form, finiteness of the simplex algorithm, simplex algorithm and table
- Initiation of the simplex algorithm: case of the linear program in normal form, M-method, two-phase method,

Chapter4: Dual methods in linear programming

- 4.1 Definitions
- 4.2 Formula for increasing the dual function and optimality criterion
- 4.3 Sufficient condition of feasible solutions in the primal problem
- 4.4 Dual simplex algorithm
- Initialization of the dual simplex algorithm

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

References:

- M. Sakarovicth, Graphes et programmation linéaire, Ed. Hermann. 1984.
- H. Mauran, Programmation linéaire appliquée, Ed. Technip, 1967.
- Kauffman, Méthodes et modèles de R.O., Ed. Dunod, 1976.
- V. Chvatal, Linear programming. W.H. Freeman and Company, 1983.Semestre :6

Semester:6
Teaching unit: Methodology
Subject: Integral transformations in Lp spaces
Credits: 5
Coefficient:2

Teaching objectives:
The essential objective of this teaching is the study of two types of transformations in Lp spaces, showing their usefulness in the resolution of certain differential equations.
Recommended prior knowledge: Topology, Measurement and Integration Module content:
Chapter 1: Lp spaces

- calls for some integration results.
- Definition and elementary properties of Lp spaces.
- Reflexibility. Separability. Dual from Lp.
- Convolution and regularization. Density theorems.

Chapter 2: Fourier Transform

- 2.1 Fourier transformation for integrable functions.
- 2.2 Properties of the Fourier transformation.
- 2.3 Inverse Fourier transformation.
- 2.4 Fourier transformation for summable square functions.

Chapter 3: Laplace Transformation

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

Evaluation 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:6
Teaching unit: Methodology
Subject: Géométrie différentielle
Credits: 5
Coefficient:2

Teaching objectives:
The student will learn differential calculus and integral calculus on abstract objects which are the differentiable varieties modeling real Euclidean spaces.
Recommended prior knowledge: Real Analysis and Linear Algebra
Content of the material:
Chapter 1 Local inversion theorem.

- Cr class applications.
- Diffeomorphisms.
- Theorem of implicit functions.

Chapter2 Rank theorem.

- 2.1 Rank.
- 2.2 Submersion theorem.
- 2.3 Immersion theorem.
- 2.4 Constant rank theorem

Chapter3 Subvarieties of Rn.

- 3.1 The notion of sub-variety.
- 3.2 Tangent spaces.
- 3.3 Sub-manifolds defined by equations.
- 3.4 Sub varieties defined by a parameterization.
- 3.5 Morse's lemma.
- 3.6 Tangent bundle to a submanifold of Rn.

Chapter4 Orientations and varieties on board.
Chapter5 Differential forms and exterior differential.

- 5.1 'linear algebra calls.
- 5.2 Alternating multilinear forms.
  - Domestic product.
  - External product.
- 5.3 Differential forms.
- 5.4 External differential. Existence and uniqueness.
- 5.5 Induced differential forms and Poincaré's Lemma.

Chapter 6 Integration of differential forms.

- 6.1 Integration on Rn.
- 6.2 Integration over a variety.
- 6.3 Stokes' formula.
- 6.4 Applications of the Stokes formula. Divergence and Green-Ostrogradski formula

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

1. Quatre-vingt-douze exercices classiques de géométrie différentielle pour la maitrise de mathématiques. Michèle Audin.
2. Cours de Mathématiques, deuxième année, Jack Dixmier.

3. Introduction aux variétés différentiables, presse Université de Grenoble1996, J.J la fontaine.
4. Notes de cours de géométrie différentielle, Claude Viterbo, 23-juin-2013

Semester:6
Teaching unit: Transverse
Subject: Ethics and professional conduct of teaching and research
Credits: 2
Coefficient: 2

Teaching objectives:
This subject aims to prepare the future teacher on the psychological level that methodological so that it can cope with the mission of teaching.
Recommended prior knowledge: Minimum academic background
Content of the subject:
Teach the student how to:

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

Ethics and professional conduct.

These titles are given for information purposes only.

Method of evaluation: 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.