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

TRAINING OFFER
L.M.D

Educational program

3rd year Fundamental Physics

Semester 1

Teaching unit	VHS	Weekly Hours			Autre*	Coeff	Credits	Evaluation Method	
	14-16 sem	C	TD	TP	(14-16 sem)			Continu	Exam
Fundamental Unit									
UF11	**202h30**	**09h00**	**4h30**			**9**	**18**		
Mathematics 1/ Analysis & Algebra 1	67h30	03h00	1h30		45h00	3	6	x	x
Physics 1/ Mechanics of a point	67h30	03h00	1h30		45h00	3	6	x	x
Chemistry 1/ Structure of Matter	67h30	03h00	1h30		45h00	3	6	x	x
Methodology Unit									
UEM11	**90h00**	**1h30**	**-**	**4h30**		**4**	**8**		
Mechanics practical work	22h30		-	1h30	45h00	1	2	x	x
Chemistry practical work	22h30		-	1h30	45h00	1	2	x	x
Computer Science 1/ Office & Web Technologies (7 weeks) + Introduction to Algorithms (8 weeks)	45h00	1h30	-	1h30	45h00	2	4	x	x
Discovery Unit									
UED11	**22h30**	**1h30**	**-**	**-**		**1**	**2**		
Discovery of University Study Methods	22h30	01h30	-	-	45h00	1	2	x	x
Environment									
Biotechnology									
Transversal Unit									
UET11	**1h30**	**-**	**-**	**-**		**1**	**2**		
Foreign Languages 1	1h30	-	-	-	45h00	1	2	x	x
Total Semester 1	**337h30**	**12h00**	**4h30**	**4h30**		**15**	**30**		

Semester 2

Teaching unit	VHS	Weekly Hours			Autre*	Coeff	Credits	Evaluation Method	
	14-16 sem	C	TD	TP	(14-16 sem)			Continu	Exam
Fundamental Unit									
UF21	202h30	09h00	4h30			9	18		
Mathematics 2/ Analysis & Algebra 2	67h30	03h00	1h30		45h00	3	6	x	x
Physics 2 / Electricity 2	67h30	03h00	1h30		45h00	3	6	x	x
Chemistry 2/ Thermodynamics & Chemical Kinetics	67h30	03h00	1h30		45h00	3	6	x	x
Methodology Unit									
UEM21	**90h00**	**1h30**	**-**	**4h30**		**4**	**8**		
Electricity practical work	22h30	-	-	1h30	45h00	1	2	x	x
Chemistry Practical Work 2	22h30	-	-	1h30	45h00	1	2	x	x
Informatique 2/Programming Language	45h00	1h30	-	1h30	45h00	2	4	x	x
Discovery Unit									
UED21	**22h30**	**1h30**	**-**	**-**		**1**	**2**		
Business Economics	22h30	01h30	-	-	45h00	1	2	x	x
History of Science									
Renewable Energies									
Transversal Unit									
UET21	**1h30**	**-**	**-**	**-**		**1**	**2**		
Foreign Languages 2	1h30	-	-	-	45h00	1	2	x	x
Total Semester 2	**337h30**	**12h00**	**4h30**	**4h30**		**15**	**30**		

Semester 3

Teaching Unit	SHV	WEEKLY VOLUME			Else*	Coeff	Credits	Evaluation method	
	14-16week	C	TD	TP	(14-16 week)			14-16 week	C
Fundamental Teaching Unit									
FTU3(O/P)	225h00	9h00	6h00		275h00	10	20	33%	67%
Series & Differential Equations	67h30	3h00	1h30	-	82h30	3	6	33%	67%
Analytical Mechanics	67h30	3h00	1h30	-	82h30	3	6	33%	67%
Vibrations & Waves	45h00	1h30	1h30	-	55h00	2	4	33%	67%
Geometric Optics & Physics	45h00	1h30	1h30	-	55h00	2	4	33%	67%
MethodologyTeaching Unit									
MTU3(O/P)	90h00	1h30		4h30	85h00	4	7	50%	50%
Practical Work on Vibrations & Waves	22h30	-	-	1h30	27h30	1	2	50%	50%
Practical Work on Geometric Optics & Physics	22h30	-	-	1h30	27h30	1	2	50%	50%
Numerical Methods and Programming	45h00	1h30	-	1h30	30h00	2	3	50%	50%
Discovery Teaching Unit									
DTU3(O/P) One subject to be chosen among:	45h00	1h30	1h30		5h00	2	2		100%
Probability & Statistics	45h00	1h30	1h30	-	5h00	2	2	-	100%
Physical crystallography									
History of Physics									
Inorganic Chemistry									
Transversal Teaching Unit									
TTU(O/P)	15h00	1h00			10h00	1	1		100%
Foreign languages 3	15h00	1h00	-	-	10h00	1	1	-	100%
Total Semester 1	375h00	13h00	7h30	4h30	375h00	17	30		

*Other = Complementary work in semester consultation (personal work of the student)

Semester 4

Teaching Unit	SVH	WEEKLY VOLUME			Other*	Coeff	Credits	Evaluation method	
	14-16 week	C	TD	TP	(14-16 week)			14-16 week	C
Fundamental Teaching Unit									
FTU4(O/P)	202h30	7h30	6h00		247.30	9	18		
Thermodynamics	67h30	3h00	1h30	-	82h30	3	6	33%	67%
Function of the Complex Variable	45h00	1h30	1h30	-	55h00	2	4	33%	67%
Quantum Mechanics	45h00	1h30	1h30	-	55h00	2	4	33%	67%
Electromagnetism	45h00	1h30	1h30	-	55h00	2	4	33%	67%
Methodology Teaching Unit									
MTU4(O/P)	112h30	3h00		4h30	87h30	5	8		
Practical work in Thermodynamics	22h30	-		1h30	27h30	1	2	50%	50%
Fluid Mechanics	45h00	1h30		1h30	30h00	2	3	50%	50%
General Electronics	45h00	1h30		1h30	30h00	2	3	50%	50%
Discovery Teaching Unit									
DTU4(O/P) One subject to be chosen among:	45h00	1h30	1h30		30h00	2	3		
Atomic & Nuclear Physics	45h00	1h30	1h30	-	30h00	2	3		100%
Concept of Astronomy and Astrophysics									
Spectroscopy									
Analysis Techniques									
Transversal Teaching Unit									
TTU4(O/P)	15h00	1h00			10h00	1	1		
Foreign languages 4	15h00	1h00	-	-	10h00	1	1		100%
Total Semester 4	375h00	13h00	7h30	4h30	375h00	17	30		

Semester 5

Teaching Unit	SVH	WEEKLY VOLUME			Other*	Coeff	Credits	Evaluation method	
	14-16 week	C	TD	TP	(14-16 week)			14-16 week	C
Fundamental Teaching Unit									
FTU1(O/P)									
Quantum Mechanics II	67h30	3h00	1h30	-	82h30	3	6	33%	67%
Statistical Physics	67h30	3h00	1h30	-	82h30	3	6	33%	67%
Special Relativity	45h00	01h30	01h30	00h		2	4	33%	67%
Mathematical Methods for Physics	45h00	1h30	1h30	-	55h00	2	4	33%	67%
Methodology Teaching Unit									
MTU4(O/P)									
Mathematical Methods for the Physics of Semiconductors	45h00	01h30	00h	01h30		2	4	50%	50%
Numerical Physics	45h00	1h30		1h30	30h00	2	4	50%	50%
Data analysis	45h00	1h30		1h30	30h00	2	4	50%	50%
Discovery Teaching Unit									
DTU4(O/P) One subject to be chosen among:	45h00	1h30	1h30		30h00	2	3		
Particle Physics The Energies Biophysics Accoustics Differential Geometry Didactic Processes	45h00	01h30	00h	00h		1	1		100%
Transversal Teaching Unit									
TTU(O/P)	15h00	1h00			10h00	1	1		
Foreign languages 1	15h00	1h00	-	-	10h00	1	1		100%
Total Semester 5	352h30	14h30	06h00	03h00		16	30		

Semester 6

Teaching Unit	SVH	WEEKLY VOLUME			Other*	Coeff	Credits	Evaluation method	
	14-16 week	C	TD	TP	(14-16 week)			14-16 week	C
Fundamental Teaching Unit									
UEF1(O/P)									
Solid State Physics	67h30	03h00	01h30	00h		3	6	33%	67%
Nuclear Physics	45h00	01h30	01h30	00h		2	4	33%	67%
Heat Transfer	45h00	01h30	01h30	00h		2	4	33%	67%
Atomic Physics	45h00	01h30	01h30	00h		2	4	33%	67%
Methodology Teaching Unit									
UEM1(O/P)	112h30	3h00		4h30		5	8		
TP Nuclear Physics	22h30	00h	00h	01h30		2	4	50%	50%
TP Atomic Physics	22h30	00h	00h	01h30		2	4	50%	50%
TP of Physical Optics	22h30	00h	01h30	01h30		2	4	50%	50%
TP Solid State Physics									
Discovery Teaching Unit									
Ethics and Deontology	22h30	01h30	00h	00h		1	1		
UED2(O/P)One subject to be chosen among:	45h00	1h30	1h30			2	3		
Plasma Physics	45h00	1h30	00	-		2	2		100%
Nanotechnologie									
Laser									
Optoelectronics									
Solar Photocell									
NouveauxMatériaux									
Transversal Teaching Unit									
UET1(O/P)									
Scientific English II	15h00	1h00	-	-	10h00	1	1		100%
Total Semester 6	307h30	11h30	06h00	06h00		17	30	307h30	

Semester: 1

UE: Fundamental

Subject: Mathematics 1/ Analysis & Algebra 1

Teaching Objectives: Of paramount importance for a scientist, the teaching of this subject allows the student to acquire basic formalisms in mathematics for analysis, algebra, and their applications.

Recommended Prerequisite Knowledge:

It is recommended to have a good mastery of mathematics at the secondary level.

Content of the Subject:

Analysis 1 Set theory.

Applications: direct image, inverse image, injection, surjection, and bijection. Equivalence relations, order relations.

Structure of the field of real numbers on IR: total order relation on IR, absolute value, interval, bounded set, reasoning by recurrence.

Real functions of one real variable: domain of definition, composition of functions, periodic functions, even functions, odd functions, bounded functions, sense of variation of functions.

Limits of functions: definition of limit, right-hand limit, left-hand limit, limits at infinity, algebraic operations on limits, limit of a composite function. Continuous functions: definition of continuity at a point, right-hand continuity, left-hand continuity, extension by continuity, algebraic operations on continuous functions, continuity of a composite function, continuous function on an interval, intermediate value theorem, continuous monotone functions.

Inverse functions: existence and properties, inverse trigonometric functions, hyperbolic functions.

Algebra 1

Recalls: internal decomposition laws, groups, rings, and fields.

Vector spaces. Bases and finite dimensions.

Linear applications, kernel, image.

Operations on linear applications, theorem on the rank of a linear application.

Evaluation mode :

Continuous assessment : 33%; Exam: 67%.

References (Books and Lecture Notes, Websites, etc.):

- Elie BELORIZKY, *Outils mathématiques à l'usage des scientifiques et des ingénieurs*, EDP Sciences, Paris, (2007).
- C. ASLANGUL, *Des mathématiques pour les sciences2,* Corrigés détaillés et commentés des exercices et problèmes, De Boeck, Bruxelles (2013).
- F. COTTET-EMARD, *Analyse : tome 1 cours et exercices corrigés*, DeBoeck, Bruxelles (2005).
- P. PHILIBOSSIAN, *Analyse: rappels de cours, exercices et problèmes résolus*, Dunod Paris (1998).
- K. ALLAB, *éléments d'analyse (Fonction d'une variable réelle)*. OPU Alger, (1986).
- J M Monier, *Algèbre 1 : cours et 600 exercices corrigés*, 2ème Ed., Dunod Paris (2000)
- C. BABA HAMED, *Algèbre 1 : rappels de cours et exercices avec solutions*, OPU (1992)
- G. CHRISTOL, *Algèbre1 : ensembles fondamentaux arithmétique polynômes*, Ellipses Paris, (1995).
- http:// www. les-mathématiques.net

Semester: 1

UE: Fundamental

Subject: Physics 1/ Mechanics of a Point Particle

Teaching Objectives:

The teaching of this subject enables students to acquire the fundamental concepts of classical mechanics related to point particles through kinematics, dynamics, and the concepts of work and energy.

Recommended Prerequisite Knowledge:

It is recommended to have a strong mastery of physics in secondary school.

Content of the subject:

1. Mathematical reminders (2 weeks):
   Dimensional equations, error calculations, vectors.
2. Kinematics of a point (3 weeks):
   Rectilinear motion, motion in space, study of special motions, motion in different coordinate systems (polar, cylindrical, and spherical), relative motion.
3. Dynamics of a point (4 weeks):
   The principle of inertia and Galilean reference frames, conservation of momentum, Newtonian definition of force (3 laws of motion), laws of forces.
4. Work and energy for a point particle (4 weeks):
   Kinetic energy, gravitational and elastic potential energy, force fields, non-conservative forces.

Evaluation mode :

Continuous assessment : 33%; Exam: 67%.

References (Books and Lecture Notes, Websites, etc.):

T. HANNI, *Mécanique générale cours et exercices*, OPU (1996).

- J. TAYLOR, *Mécanique classique,* Ellipses, Paris, (2007)
- J TAYLOR, *Incertitudes et analyse des erreurs dans les mesures physiques*, Dunod, Paris, (2000).
- H. LUMBROSO, *Mécanique du point,* 1ère an. MPSI - PCSI - PTSI - Problèmes résolus, Dunod, Paris (2002)
- D. TEYSSIER, *Mécanique du point : exercices corrigés*, Ed. Ellipses Paris, (2005)
- J. FAGET, J. MAZZASCHI, *Travaux Dirigés de Physique Généralités,* Ed. Vuibert Paris, (1970)
- J. FAGET, J. MAZZASCHI, *Travaux Dirigés de Physique Mécanique,* Ed. Vuibert Paris, (1970)

Semester: 1
UE: Fundamental
Subject: Chemistry 1/ Structure of Matter
Teaching objectives
The teaching of this subject enables students to acquire the basic formalisms in chemistry, particularly in relation to matter describing atoms and chemical bonding, chemical elements and the periodic table, and energy quantification.
Recommended Prerequisite Knowledge:
It is recommended to have a good grasp of physical sciences in secondary education.
Content of the subject:
Atom Structure
- Nucleus - Atom, element, atomic mass - Radioactivity, nuclear reactions
Energy quantification
- Semi-atomic model - Bohr model - Limitations of classical approach - Basics of quantum theory - Schrödinger equation - Quantum numbers - Probability of presence - Hydrogen atom and hydrogen-like atoms - Atomic orbitals - Electronic structure - Polyatomic atom (Screening effect)
Periodic classification of elements
- Periodicity (period and group) - Chemical properties (atomic radius, ionization energy, electron affinity, electronegativity)
Chemical Bonding
- Classical model - Covalent bonding - Molecular orbitals - σ bonding and Π bonding - Molecular energy diagram, bond order - Ionic bonding - Partial ionic character - Hybridization - Molecular geometry, Gillespie's method.
Evaluation mode :
Continuous assessment : 33%; Exam: 67%.
References (Books and Lecture Notes, Websites, etc.):
M. FAYARD, Structure électronique atomes et molécules simples, Hermann, France, (1969).
- Y. JEAN, Structure électronique des molécules : 1 de l'atome aux molécules simples 3ème Ed. Dunod, Paris, (2003).
- M. GUYMONT, *Structure de la matière* ; Belin Coll., Paris, (2003).
- G. DEVORE, *Chimie générale : T1, étude des structures*, Coll. Vuibert Paris, (1980).
- M. KARAPETIANTZ, *Constitution de la matière*, Ed. Mir, Moscou, (1980).

Semester: 1
UE: Methodology
Subject: Mechanics practical work
Teaching objectives
Consolidation of theoretical knowledge acquired in the Mechanics of Point (Physics 1) course through the application of error calculation.
Learning and visualization of phenomena related to classical mechanics.
Recommended Prerequisite Knowledge:
It is recommended to have a strong grasp of physical sciences in secondary education.
Content of the subject:

1- Error calculations
2- Verification of Newton's second law
3- Study of a physical pendulum
4- Free fall
5- Simple pendulum
6- Maxwell's pendulum
7- Study of the rotation of a solid
8- Verification of the fundamentals of circular motion - conservation of mechanical energy

Evaluation mode :
Continuous assessment : 50%; Exam: 50%.
References (Books and Lecture Notes, Websites, etc.):

- T. HANNI, *Mécanique générale cours et exercices*, OPU (1996).
- J TAYLOR, *Incertitudes et analyse des erreurs dans les mesures physiques*, Dunod, Paris, (2000).
- H. LUMBROSO, *Mécanique du point,* 1ère an. MPSI - PCSI - PTSI - Problèmes résolus,
- F. FAGET, M. MAZZASCHI, *Mécanique du point, Exercices corrigés*, Ed. Dunod Paris, (1999)

Semester: 1
UE: Methodology
Subject: Chemistry practical work 1
Teaching objectives
Introduction to laboratory techniques in chemistry, including safety rules. Basic practical work in chemistry, including handling of measuring equipment.
Recommended Prerequisite Knowledge:
It is recommended to have a good mastery of physical sciences in secondary education.
Content of the subject:
Safety and Introduction to Chemistry Lab Techniques
Acid-Base Titrations
Determination of Molar Mass
Preparation of a Solution
5- Redox Titrations

Evaluation mode :
Continuous assessment : 50%; Exam: 50%.
References (Books and Lecture Notes, Websites, etc.):
Y. JEAN, Structure électronique des molécules : 1 de l'atome aux molécules simples 3ème Ed, Dunod, Paris, (2003).
- M. GUYMONT, *Structure de la matière* ; Belin Coll., Paris, (2003).
- M. KARAPETIANTZ, *Constitution de la matière*, Ed. Mir, Moscou, (1980).

Semester: 1

UE: Methodology

Subject: Computer Science 1/ Office Automation & Web Technology (7 weeks) + Introduction to Algorithmics (8 weeks)

Teaching objectives

Mastery of computer tools involves two stages: Stage 1: Familiarization with PCs and common office automation software, as well as basic introduction to the web (HTML link, web page, internet, etc.). Stage 2: Understanding what an algorithm is and learning methods for constructing algorithms (Algorithmics).

Recommended Prerequisite Knowledge:

Having prior experience with keyboard keys manipulation.

Content of the subject:

I- Bureautique & Web Technology (7 weeks)

1. Brief history of the evolution of computing
2. PC architecture : Hardware aspect
3. Different hardware components of a PC
4. Windows operating system (and possibly Unix)
5. Software: MS Office: Word, Excel, PowerPoint.
6. Computer networks
7. Topology and operation of a network.
8. Client-server operation
9. Internet and the Web

II- Introduction to Algorithmics (8 weeks)

Notion of algorithmics: definition, syntax

10. Basic elements of an algorithm.
11. Input and output instructions
12. Control structures

    13.1 Sequence

    13.2 Test

    13.3 Repetition
13. Arrays
14. Problem-solving process
15. Development of a complete algorithm: Application: Solving a quadratic equation

Evaluation mode :

Continuous assessment : 50%; Exam: 50%.

References (Books and Lecture Notes, Websites, etc.):

M.C. Belaid, Champion de la bureautique cours et TP, OPU (2001).

www.commentcamarche.net/download/

www.openoffice.org

www.toucharger.com/

Semester: 1
UE: Discovery
Subject: Introduction to University Study Methods
Teaching objectives
The teaching of this subject allows the student to discover how to work or study at the university, including various aspects such as writing, reading in both print and digital formats.
Recommended Prerequisite Knowledge:
It is recommended to have a good understanding of the French language
Content of the subject:
Documentation
Classical documentation;
Audio-visual documentation;
Internet documentation;
Bibliography.
Learning to Read
Using the paratext of a journal or book to verify the relevance of the document in relation to the task to be accomplished;
Learning to navigate through a work or document to identify the main argumentative elements;
Knowledge capitalization through reading notes and classification.
Note-taking
Reading notes ;
Lecture or conference notes ;
Abbreviations;

8. Organization and use of notes.

Writing a Synthesis Report

12. Tips for writing;
13. Different types of texts for different intentions;
14. Writing strategies;
15. Writing a internship report ;
16. Writing a thesis.

Oral Presentation Development

17. Oral expression (Quality of expression, Degree of preparation of the presentation, Clarity of the presentation, Adherence to allotted time, Clarity of the presentation).

Training for Future Researchers

18. Ability to analyze a problem;
19. Proposing an action plan;
20. Working in a team.

Evaluation mode :
Exam:100%.
References (Books and Lecture Notes, Websites, etc.):
- D. Bertrand, H Azrour, Réapprendre à apprendre au collège, à l'université et en contexte de *travail : Gestion et maîtrise des compétences transversales. Montréal: Guérin universitaire(2004). D Chassé, R. Prégent. Préparer et donner un exposé guide pratique. Montréal: Éditions de l'École, (1990)*

- B. Dionne, Pour réussir : guide méthodologique pour les études et la recherche (4 éd.). Laval, Québec: Beauchemin. (2004)
- Université du Québec. Programme de développement des compétences informationnelles, (2007). http://pdci.uquebec.ca/. 43.

Semester: 1

UE: Discovery

Subject: Environment

Teaching objectives

Discovery of the environment and the environmental system from an ecological perspective, and raising awareness about polluters and the dangers of pollution caused.

Recommended Prerequisite Knowledge:

Foundations in Physical Sciences.

Content of the subject:

I. Environment: Definition and Relationship with Humans

Definition of environment and its applications Elements of the environment and the environmental system Humans and their role in the environment Effects of industrialization and modern technology on the environment

II. Environmental Pollution Pollution and its origins Sources of pollution Levels and types of pollution

III. Air Pollution The atmosphere and atmospheric layers Importance of air for living beings Definition of air pollution and sources of air pollution Dangers of air pollution "Acid rain"Dangers of air pollution on the ozone layer Danger of depletion of the ozone layer on the environment Proposed solutions

IV. Water Pollution Distribution of water on the Earth's surface and importance of water Areas of water exploitation Sources of water pollution Dangers of water pollution on human health

V. Methods of Treating Polluted Water Introduction Criteria for classifying water treatment Classification of means for treating sanitary water

VI. Biological Degradation Introduction Conventional biological methods for treating polluted water Technical water treatment stations in Algeria

VII. Pollution of Seas and Oceans Introduction and size of oceans Sources of marine pollution Importance of seas and oceans Chemical pollution and inherent dangers of pollution in seas and oceans Means to combat hydrocarbon pollution

VIII. Soil Pollution Introduction and sources of soil pollution Dangers caused by polluted soils and means of combating it.

Evaluation mode :

Exam:100%.

References (Books and Lecture Notes, Websites, etc.):

P BONTEMPS, *G.*ROTILLON, *Economie de l'environnement*, Paris, La Découverte, Repères, (1998)
http ://www.wikipedia.org/wiki/Environnement
www.toutsurlenvironnement.fr
www.environnement-magazine.fr

Semester: 1

UE: Discovery

Subject: Biotechnology

Teaching objectives

With this subject, the student will have discovered new sciences such as biotechnology and biotechnology sources.

Recommended Prerequisite Knowledge:

It is recommended to have a good mastery of physical sciences in secondary school.

Content of the subject:

I. Biotechnology

Definition, Applications, selection of materials for biomaterials: metals and metallic alloys, ceramics, polymers, and natural-origin materials.

II. Chemical Biotechnology

Multi-step synthesis of various active principles - Hemi and total synthesis.

Solid-phase and liquid-phase peptide synthesis of bioactive peptides.

Physico-chemical characterization, vectorization, and study of the mode of action of synthetic or non-synthetic bioactive molecules.

Demonstration, characterization, and analysis of the functioning of different classes of biological receptors. Study of ligand-receptor interactions, applications.

Enzymatic catalysis: principles and applications in therapeutic chemistry.

III. Environmental Biotechnology

Definition of the concept of bioremediation, Types of pollution, Mechanism of evolution of pollution, Specific characteristics of hydrocarbon degradation, Bioremediation processes, Ex-situ processes.

Characterization of undesirable and toxic substances, Composition of wastewater, Main calculation parameters, Treatment techniques. Water treatment by aerobiosis.

Principle and sizing of activated sludge treatment plants.

Fermentation processes with cellular recycling.

Material balances and microbial kinetics applied to this type of fermentation.

Evaluation mode :

Exam: 50%.

References (Books and Lecture Notes, Websites, etc.):

Semester: 1

UE: Transversal

Subject: Foreign languages 1

Teaching objectives

Acquisition of a scientific language culture and the basics of everyday language

Acquisition of the ability to use techniques for oral presentation.

Recommended Prerequisite Knowledge:

It is recommended to have a good level in English/French.

Content of the subject:

For English 1:

Sentences

Tenses

Noun, Adjective, Article, Adverbs,… etc.

Introduction to phonetics and phonology

Speech mechanism

Sounds of English (vowels, diphthongs, consonants)

Transcription and classification

For French 1:

Grammar

Conjugation

Spelling

Text studies

Readings

Evaluation mode :

Exam: 50%.

References (Books and Lecture Notes, Websites, etc.):

Semester: 2
UE: Fundamental
Subject: Mathematics2/ Analysis & Algebra 2
Teaching Objectives:

Of primary importance for a scientist, this subject allows the student to acquire:
- in the analysis part: methods for calculating derivatives and integrals, different forms of limited development, as well as methods leading to the resolution of differential equations necessary for solving physics problems.
- in the algebra part: matrices and their properties, as well as matrix calculations.

Recommended Prerequisite Knowledge:
It is recommended to have a solid understanding of the fundamental basics of integral calculus and primitives, as well as the mathematics taught in Semester 1 of Year 1 in Material Sciences.

Content of the subject:
Analysis

Differentiation: Definition of the derivative, right and left derivatives, differentiable function on an interval, differential notion, geometric interpretation.
Calculation of derivatives, derivatives of a composite function, derivative of an inverse function, calculation of successive derivatives, Rolle's theorem, mean value theorem, L'Hôpital's rule.
Taylor's formula, Mac-Laurin's formula.
Limit development: Sum, product, quotient, integration, derivation, composition of limit developments, table of usual limit developments around the zero point.
Primitives and integrals: Primitive function, integration process, integration by parts, integration by change of variables, integration of rational functions, simple integrals.
Double integrals, table of usual primitives.
First-order differential equations.
Second-order differential equations.
Functions of two variables.

Algebra

Matrices.
Eigenvalues and eigenvectors.
Diagonalization of a matrix.
Determinants.
Systems of equations.

Evaluation mode :
Continuous assessment : 33%; Exam: 67%.

References (Books and Lecture Notes, Websites, etc.):

- Elie BELORIZKY, *Outils mathématiques à l'usage des scientifiques et des ingénieurs*, EDP Sciences, Paris, (2007).
- Walter APPEL, *Mathématiques pour la physique et les physiciens*!, 4ème Ed., H&K Edition, Paris, (2008).
- C. ASLANGUL, *Des mathématiques pour les sciences, Concepts, méthodes et techniques pour la modélisation*, De Boeck, Bruxelles (2011).
- C. ASLANGUL, *Des mathématiques pour les sciences2,* Corrigés détaillés et commentés des exercices et problèmes, De Boeck, Bruxelles (2013).
- Piskounov, *Tome 2, Calcul différentiel et intégral*, Ed. MIR, (1976).
- http:// www. les-mathématiques.net

Semester: 2

UE: Fundamental

Subject: Physics 2 / Electricity 2

Teaching Objectives:

The objective of teaching this subject is to provide the student with the fundamentals of Electricity and Electromagnetism.

Recommended Prerequisite Knowledge:

It is recommended to have a good understanding of the physics taught in S1.

Content of the subject:

1- Electrostatics (5 weeks)

- Electric charges and fields
- Electrostatic potential
- Electric field flux
- Gauss's law
- Electric dipole

2- Conductors (2 weeks)

1. Definition and properties of conductors in equilibrium
2. Electrostatic pressure
3. Capacitance of a conductor and capacitor.

3- Electrodynamics (5 weeks)

1. Electric conductors
2. Ohm's law
3. Joule's law
4. Electrical circuits
5. Application of Ohm's law to networks
6. Kirchhoff's laws.

4- Electromagnetism (3 weeks)

1. Definition of a magnetic field
2. Lorentz force
3. Laplace's law
4. Biot-Savart law
5. Magnetic dipole.

Evaluation mode :

Continuous assessment : 50%; Exam: 50%.

References (Books and Lecture Notes, Websites, etc.):

- Y. GRANJON ; Exercices et Problèmes d'Electricité ; Dunod, Paris, (2003)
- J L CAUBARRERE, Electricité et ondes : cours et travaux pratiques OPU Alger, (1986)
- Collectif Ediscience : La physique en fac : électrostatique et électrocinétique 1ère et 2ème année ; Ediscience international, (2010)
- M.-N. SANZ, D. CHARDON, F. VANDENBROUCK, B. SALAMITO, Physique tout-en-un PC, PC* : cours et exercices corrigés ; Dunod, Paris (2014)
- R. A. SERWAY, J. W. JEWETT, JR., A. DUCHARME, M. PÉRIARD, Physique - Tome 2 Electricité et magnétisme, Ed. De Boeck, (2013)
- D. FEDULLO, T. GALLAUZIAUX, Electricité : Réaliser son installation par soi-même, Ed. Eyrolles, (2012)

Semester: 2
UE: Fundamental
Subject: Chemistry 2/ Thermodynamics & Chemical Kinetics

Teaching Objectives:
The acquisition of basic formalisms in thermodynamics and its fundamental principles introducing thermodynamic quantities and state functions such as enthalpy and entropy as well as the kinetics of chemical reactions.

Recommended Prerequisite Knowledge:
It is recommended to have a mastery of chemistry from S1.

Content of the subject:

Generalities on thermodynamics: system, state of a system, variables, and state functions. Notion of equilibrium and transformation of a system. Notion of temperature. Different forms of energy. Ideal gas equation.
First law of thermodynamics: Internal energy, work, heat. Statement of the first law. Differential expression of the first law. Application: transformation of an ideal gas (isochoric, isothermal, isobaric, adiabatic). Chemical systems; heat of reaction, bond energy. Examples of application to physical systems.
Second law of thermodynamics: Natural evolutions. Notions of entropy and free enthalpy, thermodynamic machines. Chemical equilibria. Law of mass action, equilibrium constant. Factors of equilibrium. Statement of the third law.
Introduction to chemical kinetics: Definition of reaction rate. Main factors influencing the rate of chemical reactions, concentration, temperature. Integrated rate laws. Notion of reaction mechanism. Reversible reactions. Chain reactions. Activation energy and catalysis.

Evaluation mode :
Continuous assessment : 33%; Exam: 67%.

References (Books and Lecture Notes, Websites, etc.):

- T. BECHERRAWY, Vibrations et Ondes, Tomes 1-4, Ed. Hermes-Lavoisier, (2010).
- H. DJELOUAH, Vibrations et Ondes Mécaniques, OPU, (2011).
- J. BRUNEAUX, Vibrations et Ondes, Ed. Marketing, (2010).
- Y. GRANJON, Exercices et problèmes d'électricité,;Dunod, Paris, (2003).
- L. BOREL, D. FAVRAT, Thermodynamique et énergétique, Vol.1.de l'Energie à l'Exergie, PPUR, Collection Mécanique, (2011)
- J-N. FOUSSARD, S. MATHE, Thermodynamique - Bases et applications, Cours et exercices corrigés, 2ème Ed. Dunod, (2010)
- R. MAUDUIT, Thermodynamique en 20 fiches, Ed. Dunod, (2013)

Semester: 2
UE: Methodology
Subject: Electricity practical work
Teaching objectives

- Consolidation of theoretical knowledge about Electricity.
- Learning and visualization of phenomena related to Electricity.

Recommended Prerequisite Knowledge:
It is recommended to have completed the practical work taught in S1 and to have mastered physical sciences in secondary school.
Content of the subject:

- Association and measurement of resistances
- Association and measurement of capacitances
- Charging and discharging of a capacitor
- Verification of Biot-Savart's law
- Study of a transformer
- Determination of the Earth's magnetic field
- Wheatstone bridge.

Evaluation mode :
Continuous assessment : 50%; Exam: 50%.
References (Books and Lecture Notes, Websites, etc.):
- J L CAUBARRERE, *Electricité et ondes : cours et travaux pratiques* OPU Alger, (1986)
- A. BENTOUNSI, *Electricité générale: T2, Exercices résolus*, OPU, Alger, (1992)
- Collectif Ediscience*: La physique en fac : électrostatique et électrocinétique 1ère et 2ème année* ; Ediscience international, (2010)
- D. FEDULLO, T. GALLAUZIAUX, *Electricité : Réaliser son installation par soi-même, Ed. Eyrolles, (2012)*
- De H. LARGEAUD, *Le schéma électrique, Ed. Eyrolles, (2006)*

Semester: 2

UE: Methodology

Subject: Chemistry Practical Work 2

Teaching objectives

- Consolidation of theoretical knowledge about thermodynamics
- Learning and visualization of phenomena related to thermodynamics.

Recommended Prerequisite Knowledge:

It is recommended to have completed the practical work taught in S1 and to have mastered physical sciences in secondary school.

Content of the subject:

Thermodynamics

1- Measurement of heat capacity of liquids.
2- Thermodynamic properties of a gas mixture.
3- Measurement of the specific heat ratio of a gas.
4- First law of thermodynamics

Kinetics

1- Inversion of sucrose.
2- Saponification of an ester (second order).
3- Decomposition of hydrogen peroxide.

Evaluation mode :

Continuous assessment : 50%; Exam: 50%.

References (Books and Lecture Notes, Websites, etc.):

- R. MAUDUIT, *Thermodynamique en 20 fiches*, Ed. Dunod, (2013)
- B. FREMAUX, Éléments de cinétique et de catalyse, Éd. Tec. & Doc, (1989).
- B. DIU et al, *Thermodynamique,* Editions Hermann, Paris, (2007).

Semester: 2

UE: Methodology

Subject: Informatique 2/Programming Language

Teaching objectives

Mastery of computer tools through the teaching of advanced programming languages and the design of simple computer codes.

Recommended Prerequisite Knowledge:

It is recommended to have mastery in the use of computers.

Content of the subject:

1- History of programming languages.
2- Introduction to the FORTRAN language.
3- Development files of a FORTRAN program.
4- Organization of a FORTRAN program.
5- General structure of a FORTRAN program.
6- Mathematical operators and functions.
7- Input and output operations.
8- Conditional statements.
9- Looping .

Arrays and subroutines.

Evaluation mode:

Continuous assessment: 50%; Exam: 50%.

References (Books and Lecture Notes, Websites, etc.):

Pour MATLAB

- M. DJEBLI & H. DJELOUAH, *Initiation à MATLAB*, OPU, (2013).
- R. DUKKIPATI, *MATLAB, an introduction with applications*, New Age International Publishers, India, (2010).
- C. WOODFORD and C. Phillips, *Numerical methods with worked examples: MATLAB edition*, 2nd Ed. Springer Ltd, (2013).

Pour C et C++

- C. DELANNOY, *''C++ pour les programmeurs C*'', 6ème Ed., Eyrolles, Paris, (2004).
- C. CASTEYDE, ''Cours de C/C++'', Copyright, (2005).

Pour FORTRAN

- B. HAHN, ''*Introduction to Fortran 90 for scientists and engineers*'', Capetown University, South Africa, (1993).
- Ph. D'Anfray, ''*Fortran 77*'', Université Paris XIII, (1998).
- P. CORDE et A. FOUILLOUX, *Langage Fortran, Support de cours*, IDRIS, (2010).
- S. LIPSCHUTZ, *Programmation fortran : Théorie et Applications /*

Semester: 2
UE: Discovery
Subject: Business Economics
Teaching objectives
Teaching this subject allows the student to discover the field of business in general.

Recommended Prerequisite Knowledge:
It is recommended to have mastery in mathematics.
Content of the subject:
In construction
Evaluation mode:
Exam: 100%.
References (Books and Lecture Notes, Websites, etc.):

Semester: 2
UE: Discovery
Subject: History of Science

Teaching objectives

To introduce the student to the evolution of sciences from antiquity to the 20th century, and the scientists who have marked the time through their discoveries.

Recommended Prerequisite Knowledge:

It is recommended to understand the French language.

Content of the subject:

Antiquity (Geocentrism):

Aristotle, Ptolemy, Plato.

Renaissance (Heliocentrism):

N. Copernicus, On the Revolutions of the Celestial Spheres, Galileo, Dialogue Concerning the Two Chief World Systems [1632], Francis Bacon, NovumOrganum, René Descartes, Discourse on the Method of Rightly Conducting the Reason and Seeking Truth in the Sciences [1637], J. Locke, An Essay Concerning Human Understanding [1690],

Enlightenment:

Voltaire, Letters Concerning the English Nation, see the edition titled Letters on the English). D. Hume, An Enquiry Concerning Human Understanding [1748].
Denis Diderot and Jean Le Rondd'Alembert, Preliminary Discourse, Encyclopedia.
Condorcet, Sketch for a Historical Picture of the Progress of the Human Mind [1793-1794].

The 19th century:

Laplace, Pierre-Simon, A Philosophical Essay on Probabilities, Paris, 1814. Laplace, The System of the World, Auguste Comte (Course on Positive Philosophy) Alexander von Humboldt, Cosmos Karl Marx, Capital, Claude Bernard, An Introduction to the Study of Experimental Medicine [1865].

The 20th century:

Henri Poincaré, Science and Hypothesis.

Evaluation mode :

Exam: 100%.

References (Books and Lecture Notes, Websites, etc.):

- P. GUAYDIER ; Histoire de la physique PUF paris 1972
- I. STEWART, A. MUCHNIK , 17 équations qui ont changé le monde , Ed. LAFFONT, (2014)
- R. FEYNMAN, M. GOTTLIEB, R. LEIGHTON, *Révisez la physique avec Feynman - Méthodes, astuces et exercices [Broché],* Ed. Dunod, (2014).
- R. FEYNMAN, *Lumière et Matière, une étrange histoire,* Ed. Sciences, (2014).
- E. KLEIN, *Discours sur l'origine de l'Univers,* Ed. Sciences, (2012).
- E. KLEIN, P. MUSSO, *D'où viennent les idées (scientifiques) ?,* Ed. Manucius, (2013).

Semester: 2

UE: Discovery

Subject: Renewable Energies

Teaching objectives

With this subject, the student will have discovered the fabulous world of physics.

Recommended Prerequisite Knowledge:

To be familiar with the physical sciences taught in the first year of the SM (Science and Mathematics.

Content of the subject:

Overview of energy:

What is energy? History of energy and the energy cycle on Earth.

Physical quantities and concepts of thermodynamics.

The world and energy

- Non-renewable energy sources and the global situation, energy challenges, energy efficiency, energy security.

Renewable energies in the world. Solar energy:

Solar thermal energy

Photovoltaic solar energy

Storage of solar energy.

Wind energy.

Biomass.

Ocean energy (conversion of thermal energy, waves, tides, ocean currents, environmental impact).

Hydraulic energy.

Geothermal energy (availability, low, medium, and high enthalpy reservoirs). Hydrogen (production and storage, fuel cells, environmental impact).

Operation and interconnection of a solar energy source on the power grid.

Fuel cells, micro turbines, micro and nano energy plants.

The energies of the future.

Evaluation mode :

Exam: 100%.

References (Books and Lecture Notes, Websites, etc.):

G, Boyle. *Renewable Energy,* 2nd ed., Oxford, (2004)

A. V, Da Rosa*, Fundamental of Renewable Energy Processes,* Elsevier Academic Press, (2005)

J. H. Kunstler*, La fin du pétrole : Le vrai défi du XXIe siècle,* Plon, (2005).

B. Sorenson, *Renewable Energy Conversion*, *Transmission, and Storage*, Elsevier Academic Press, (2008)

B. Wu, *N. Zargari, S. Kouro, Power Conversion and Control of Wind Energy Systems,* Wiley, (2011).

http://www.mrnf.gouv.qc.ca/energie/statistiques/statistiques-consommation-energie.jsp

http://www.mrnf.gouv.qc.ca/publications/energie/strategie/strategie-energetique-2006-2015.pdf

www.energybulletin.net

Semester: 2

UE: Transversal

Subject: Foreign Languages 2

Teaching objectives

Improvement of language acquisition and skills in scientific writing techniques.

Recommended Prerequisite Knowledge:

It is recommended to have a good level in English/French.

Content of the subject:

For English 2:

1- Grammar.
2- Translation from English to French and French to English.
3- Scientific articles.
4- Scientific reviews.

For French 2:

1- Introduction to scientific writing.
2- Francophone authors.
3- Illustrated works.
4- Scientific article in French.
5- Scientific work in French.

Evaluation mode :

Exam: 100%.

References (Books and Lecture Notes, Websites, etc.):

II–Organization sheets for Teaching Units
(Drawing up a form for each TU)

II–Organization sheets for Teaching Units

(Drawing up a form for each TU)

Semester :3

Fundamental Teaching Unit

Distribution of the hourly volume of the TU and its subjects	Courses :**135h00** TD : **90h00** TP: - Personal work:**275h00**
Credits and coefficients assigned to the TU and its subjects	TU: **Coefficient = 10** **Credits= 20** **Subject 1*Series & Differential Equations*** Credits : 6 Coefficient: 3 **Subject2** :***Analytical Mechanics*** Credits : 6 Coefficient: 3 **Subject3**: ***Vibrations &Waves*** Credits : 4 Coefficient: 2 **Subject4**: ***GeometricOptics&Physics*** Credits : 4 Coefficient: 2
Evaluation method (continuous or exam)	**Continuous:33%;Exam:67%**

Semester :3

Fundamental Teaching Unit

Description of the subjects	***Series & Differential Equations*** Calculation of integrals and numerical series and methods for solving first and second order differential equations. Application of Laplace and Fourier transforms. ***Analytical Mechanics*** Classical Mechanics and the powerful Lagrangian and Hamiltonian formalisms for solid motion **Vibrations&Ondes** The different types of vibratory or oscillatory movements applied to linear systems with mechanical waves and their propagations ***OptiqueGéométrique& Physique*** The fundamental laws of geometric and physical optics as well as the techniques and instruments used with several applications.

Semester:3

Methodology Teaching Unit

Distribution of the hourly volume of the TU and its subjects	Courses :**22h30** TD : - TP: **67h30** Personal work:**85h00**
Credits and coefficients assigned to the TU and its subjects	TU:**Coefficient =4 Credits= 7** **Subject1:*Practical Work on Vibrations & Waves*** Credits : 2 Coefficient: 1 **Subject2 :*Practical Work on Geometric Optics & Physics*** Credits : 2 Coefficient: 1 **Subject3 :*Numerical Methods and Programming*** Credits : 3 Coefficient: 2
Evaluation method (continuous or exam)	**Continuous: 50%;Exam:50%**

Semester:3

Methodology Teaching Unit

Description of the subjects	***Practical Work on Vibrations & Waves*** Consolidation of the theoretical knowledge on Vibrations and Waves. Learning and visualization of the phenomena related to Vibrations and Waves ***Practical Work on Geometric Optics & Physics*** Consolidation of theoretical knowledge on Vibrations and Waves. Learning and visualization of phenomena related to Optics. ***Numerical Methods and programming*** Specialization in advanced programming languages and study of numerical methods for solving systems of algebraic equations.

Semester:3

Discovery Teaching Unit

Distribution of the hourly volume of the TU and its subjects	Courses :**22h30** TD : - TP: **22h30** Personal work:**05h00**
Credits and coefficients assigned to the TU and its subjects	TU: **Coefficient =2** **Credits= 2** **<u>Unematière àchoisirparmi:</u>** **Subject1:*Probability & Statistics*** Credits : 2 Coefficient: 2 **Subject2 :*Physical crystallography*** Credits : 2 Coefficient: 2 **Subject3 :*History of Physics*** Credits : 2 Coefficient: 2 **Subject4:*Inorganic Chemistry*** Credits : 2 Coefficient: 2
Evaluation method (continuous or exam)	**Exam: 100%**

Semester:3

Discovery Teaching Unit

Description of the subjects	**Probability & Statistics** These mathematical branches are closely related to physics in the field of randomness and probabilistic theory as well as in estimation and data analysis. **Physical crystallography** Definitions and properties of the crystalline state and the crystal lattice and its different modes. The laws of diffraction and the different bonds in crystals. **History of Physics** The fabulous evolution of physics in time and within humanity through the development of the branches of physics and the discoveries of scientists **Inorganic Chemistry** Properties and treatment of ionic solutions, acids and bases, equilibrium in solution, solubility and redox. alkali and alkaline earth metals.

Semester :3

Transversal Teaching Unit

Distribution of the hourly volume of the TU and its subjects	Courses :**15h00** TD : - TP: - Personal work:**10h00**
Credits and coefficients assigned to the TU and its subjects	TU: **Coefficient = 1** **Credit =1** **Subject**:***Foreignlanguages3*** Credit : 1 Coefficient: 1
Evaluation method (continuous or exam)	Exam : 100%
Description of the subjects	**Foreign languages 3 :English 3 orFrench 3** Oral and written expression, communication and methodology in English and French

Semester :4

Fundamental Teaching Unit

Distribution of the hourly volume of the TU and its subjects	Courses :**110h30** TD : **90h00** TP: - Personal work:**247h30**
Credits and coefficients assigned to the TU and its subjects	TU:**Coefficient = 9 Credits= 18** **Subject1:*Thermodynamics*** Credits : 6 Coefficient: 3 **Subject2 :*Function of the Complex Variable*** Credits : 4 Coefficient: 2 **Subject 3 :*Quantum Mechanics*** Credits : 4 Coefficient: 2 **Subject 3 :*Electromagnetism*** Credits : 4 Coefficient: 2
Evaluation method (continuous or exam)	**Continuous:33%;Exam:67%**

Semester :4

Fundamental Teaching Unit

Description of the subjects	**Thermodynamics** The fundamental laws of thermodynamics and conservation of energy. Thermodynamic functions and irreversibility. **Function of the Complex Variable** Holomorphic functions and elementary functions. The fundamental and residue theorems and their applications. **Quantum Mechanics** Elementary particles in quantum mechanics. The mathematical formalism and postulates of quantum mechanics. **Electromagnetism** The magnetic field, the Lorentz force and Maxwell's equations. The propagation and radiation of electromagnetic waves.

Semester :4

Methodology Teaching Unit

Distribution of the hourly volume of the TU and its subjects	Coursese :**45h00** TD : - TP: **67h30** Personal work:**87h30**
Credits and coefficients assigned to the TU and its subjects	TU: **Coefficient = 5 Credits=** **8Subject1:*Practical work in Thermodynamics*** Credits : 2 Coefficient: 1 **Subject2 :*Fluid Mechanics*** Credits : 3 Coefficient: 2 **Subject3 :*General Electronics*** Credits : 3 Coefficient: 2
Evaluation method (continuous or exam)	**Continuous:50%;Exam:50%**
Description of the subjects	**Practical work in Thermodynamics** Consolidation of theoretical knowledge on Thermodynamics. Learning and visualization of phenomena related to thermodynamics. **Fluid Mechanics** Fundamentals of Fluid Mechanics: statics, kinematics and dynamics of perfect and viscous fluids with application examples (practical work). **General Electronics** Mastery and calculation of electrical networks and circuits of the RL, RC and RLC types as well as quadrupoles and diodes accompanied by a set of application examples in the form of practical work.

Semester :4

Methodology Teaching Unit

Semester :4

Discovery Teaching Unit

Distribution of the hourly volume of the TU and its subjects	Courses :**22h30** TD : - TP: **22h30** Personal work:**30h00**
Credits and coefficients assigned to the TU and its subjects	TU: **Coefficient = 2** **Credits= 3** **<u>One subject to choose from:</u>** **Subject1:*Atomic & Nuclear Physics*** Credits : 3 Coefficient: 2 **Subject2 :*Notions of Astronomy and Astrophysics*** Credits : 3 Coefficient: 2 **Subject3** :***Spectroscopy*** Credits : 3 Coefficient: 2 **Subject 4** : ***Analysis Techniques*** Credits : 3 Coefficient: 2
Evaluation method (continuous or exam)	**Exam: 100%**

Semester :4

Discovery Teaching Unit

Description of the subjects	**Atomic & Nuclear Physics** Discover the infinitely small and understand physics at the scale of the atom and the nucleus **Notions of Astronomy and Astrophysics** Discover the infinitely large with our galaxy and the solar system, planets and stars. **Spectroscopy** Understand wave-corpuscle duality, atomic spectroscopy and induced reactions. ***Analysis Techniques*** Discover the techniques of physical-chemical analysis using atomic absorption spectrophotometers, infrared spectrometers, NMR spectroscopes and mass spectrometers.

Distribution of the hourly volume of the TU and its subjects	Courses :**15h00** TD : - TP: - Personal work:**10h00**
Credits and coefficients assigned to the TU and its subjects	TU: **Coefficient = 1** **Credit =1** **Subject:*Foreignlanguages4*** Credit : 1 Coefficient: 1
Evaluation method (continuous or exam)	**Exam: 100%**
Description of the subjects	**Foreign languages 4 : English 4 orFrench 4** This unit is a continuation of Foreign Languages 3. The objectives are: - Active participation of the student in his/her own training. - Introduction to communication techniques. - Introduction to bibliographic research techniques. - Learning to write and present a given study of general culture. - Introduction to internet research techniques.

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

Semester :3

Fundamental Teaching Unit

Teaching objectives

Of capital importance for a physicist, the teaching of this subject allows the student to acquire the methods of calculating integrals in different dimensions as well as the methods leading to the solution of differential equations necessary for the solution of physics problems.

Recommended background knowledge

It is recommended to master the subjects " Mathematics 1 & 2 " taught in 1st year Sciencesof the Matter .

Subject Content:

Chapter1:Simple and multiple integrals: (2 weeks)

Recall the Riemann integral and the calculation of primitives. Double and triple integrals. Application to the calculation of areas, volumes...

Chapter2:Integral improper : (2 weeks)

Integrals of functions defined on an unbounded interval.

Integrals of functions defined on a bounded interval, infinite at one end.

Chapter3:Differential equations : (2 weeks)

Ordinary differential equations of the 1st and 2nd order. Elements of partial differential equations.

Chapter4:Series: (3 weeks)

Numerical series.

Sequences and series of functions Integer series, Fourier series

Chapter5:Laplace transformation: (3 weeks)

Definition and properties.

Application to the solution of differential equations.

Chapter6:Fourier Transform: (3 weeks)

Definition and properties.

Application to the solution of differential equations.

Evaluatingmode: Continuous: 33% Exam: 67%

References (Books and handouts, websites, etc) :

ElieBELORIZKY,Outilsmathématiquesàl'usagedesscientifiquesetdesingénieurs,EDPSciences,Paris, (2007).

WalterAPPEL,*Mathématiquespourlaphysiqueetlesphysiciens!*,4èmeEd.,H&KEdition,Paris, (2008).

C. ASLANGUL,Desmathématiquespourlessciences,Concepts,méthodesettechniquespourlamodélisation, DeBoeck,Bruxelles(2011).

C.ASLANGUL,Desmathématiquespourlessciences2,Corrigésdétaillésetcommentésdesexercicesetproblèmes,DeBoeck, Bruxelles(2013).

Semester :3

Fundamental Teaching Unit

Teaching objectives

J.M.RAKOSOTON,J.E.RAKOSOTON,*Analysefonctionnelleappliquéeauxéquationsauxdérivéespartielles*,Ed.PUF,(1999).

S.NICAISE,*Analysenumériqueetéquationsauxdérivéespartielles:coursetproblèmesrésolus***,** Ed.Dunod,Paris,(2000).

Semester :3

Fundamental Teaching Unit

Teaching objectives

Knowledge of the foundations of classical mechanics, whether at the material point scale (point mechanics) or at the solid scale (solid mechanics), through the teaching of Lagrange and Hamilton formalisms.

Recommended background knowledge

It is recommended to master the subjects " Physics 1 & 2 " taught in 1st year Sciences of the Matter

Subject Content:

Chapter 1 : Recalls of classical mechanics

Kinematics of a particle. Dynamics of a particle. Work and energy. Systems with N particles and external forces. Degrees of freedom.

Chapter 2: Lagrange Formalism

Generalized coordinates. Functional variation. The Lagrangian. Curvilinear coordinates. Holonomic and non-holonomic constraints.

Applications: Particle in a gravitational field, particle bound to a spring, two body problem, the central potential.

Chapter 3: Hamilton's formalism

Legendre transformation. The Hamiltonian. Canonical variables and Poisson brackets. Generalized moments. Canonical transformations. The Hamilton-Jacobi method. The phase space. Angle-action variables and generating function. Integrable systems.

Chapter 4: Motion of an Undeformable Solid

Degrees of freedom of a solid. Kinetic energy. Principal axes and tensor of inertia. Kinetic moment of a solid. Vector approach and Euler equations. Lagrangian approach and Euler angles. Symmetrical spinning top

Chapter 5: Lagrangian Mechanics of Continuous Media

The passage to the continuous limit. Classical field theory. Euler-Lagrangian field equations**.**

Chapter 6: Liouville's theorem. Hamilton-Jacobi equation.

Evaluatingmode: Continu: 33%Examen:67%

References (Books and handouts, websites, etc) :

A.CHARLIER,A.BERARD,M.CHARLIER,*MécaniqueAnalytique-Ducoursauxtravauxdirigés,*Ed.Ellipses, (1989).

Semester :3

Fundamental Teaching Unit

Teaching objectives

LANDAUet LIFCHITZ,*Mécanique*,Editions Mir(Moscou)etEllipses(Paris)

BOUCIF, Introduction àlamécaniqueanalytique,DeBoeck, Bruxelles,(2012)

TAYLOR,*Mécaniqueclassique*,Ellipses,Paris, (2007)

MARTIN-ROBINE,Histoire duprincipe de moindreaction, Vuibert, Paris, (2006)

GOLDSTEINet al,*Classical mechanics*, 3rdEd,Addison-Wesley(USA), (2001).

Semester :3

Fundamental Teaching Unit

Teaching objectives

Theoretical knowledge, understanding and resolution of vibratory movements and the different types of oscillations generated, as well as mechanical waves and wave movements generated.

Recommended background knowledge

It is recommended to master the subjects " Physics 1 & 2 " taught in 1st year Sciences of the Matter.

Subject Content:

PARTI :VIBRATIONS

Chapter 1: Generalities on vibrations.

Definition of a vibratory motion. Examples of vibratory systems. Periodic motions

Chapter 2: Linear systems with one degree of freedom

2.1. Free oscillations. The harmonic oscillator. Eigenpulsation of a harmonic oscillator. The energy of a harmonic oscillator

2.2 Damped free oscillations. Damping forces. Equation of motion. Pseudoperiodic oscillations (logarithmic decrement, quality factor)

2.3 Forced free oscillations. Definition. Case of a sinusoidal excitation (resonance, phase shift). Case of any periodic excitation.

2.4 Forced damped oscillations. Equation of motion. Transient regime, permanent regime. Passing band. Quality factor

2.5 Analogy between mechanical and electrical oscillating systems

Chapter 3: Linear systems with several degrees of freedom

3.1 Systems with 2 degrees of freedom (free cases - natural pulsations), damped and forced damped.

3.2 Systems with N degrees of freedom (general behavior)

PART II: MECHANICAL WAVES

Chapter 4: Generalities on mechanical waves

4.1 Classification of Waves

4.2 General integral of the general equation of progressive waves.

4.3 Phase velocity, group velocity

4.4 Notion of wave front. Example of plane waves, spherical waves

4.5 Reflection and transmission of waves

4.6 Relation between the different quantities representing the wave

Semester :3

Fundamental Teaching Unit

Teaching objectives

Chapter 5: Transverse Waves on a String

5.1 Propagation equation. Characteristic impedance. Energy of a progressive wave. Reflection and transmission of waves. Standing waves

Chapter 6: Longitudinal Waves in Fluids

6.1 Plane Waves in a Cylindrical Pipe. Equation of waves in a gas. Wave equation in a liquid. Acoustic impedance. Characteristic impedance. Energy transported by a wave. Coefficients of reflection and transmission of waves (boundary conditions)

6.2 Doppler Effect

Chapter 7: Elastic Waves in Solids

Evaluatingmode: Continuous: 33%Exam:67%

References (Books and handouts, websites, etc) :

T.BECHERRAWY,*Vibrations etOndes*,Tomes1-4, Ed.Hermes-Lavoisier,(2010).

H.DJELOUAH,Vibrationset OndesMécaniques,OPU,(2011).

J.BRUNEAUX,*Vibrations et Ondes*,Ed.Marketing, (2010).

Semester :3

Fundamental Teaching Unit

Teaching objectives

The student acquires the theoretical knowledge and fundamental laws of geometrical and physical optics as well as the techniques and instruments used with several applications.

Recommended background knowledge

It is recommended to master the subjects " Physics 1 & 2 " taught in 1st year Sciences of the Matter.

Subject Content:

Chapter 1: Geometrical Optics

1.1- Principles and laws of geometrical optics 1.2- Notions of refringence

1.3- Snell-Descartes laws, Fermat's principle and Huygens' construction

1.4- Spherical mirrors and plane mirrors: position formula and image construction

1.5- Plane and spherical dioptre: conjugation formula, magnification, notions of stigmatism and image construction

1.6- Prism: formulas, deviation and dispersion

1.7- Thin lenses: position formulas and image construction 1.8- Optical instruments: eye, magnifying glass, microscope, ...

Chapter 2: Wave Optics

2.1- Generalities

2.2- Principle of superposition of two monochromatic waves of the same frequency 2.3- Interference conditions: Notion of coherence

2.4- Interference of two coherent waves

2.5- Multiple wave interference: Michelson and Perot-Fabry interferometers 2.6- Interference in polychromatic light

Chapter 3: Diffraction and its Applications

3.1- Fresnel diffraction and Fraunhoffer diffraction

3.2- Diffraction by a rectangular aperture and diffraction by a circular aperture

Chapter 4: Polarization

4.1- Transversality of waves

4.2- Structure of a linearly polarized wave

4.3- Reflection and refraction by transparent isotropic bodies

Semester :3

Fundamental Teaching Unit

Teaching objectives

Chapter 5: Lasers and their Applications

Evaluating mode: Continuous:33% Exam:67%

References (Books and handouts, websites, etc) :

D.FIEL&P. COLIN,*Optique-Coursetexercicescorrigés*, Ed.Ellipses, (1999)

J-P.PEREZ,Optique-FondementsetApplicationsavec250exercicesetproblèmesrésolus,Ed.Dunod, (2004)

F.WELL,OptiquePhysique- Cours : Propagation de lalumière, Ed. Ellipses, (2005)

T.BECHERRAWY,OptiqueGéométrique -Courset exercicescorrigés, Ed.Debœck, (2006)

E.AMZALLAG,LaPhysique en Fac - Optique-Coursetexercicescorrigés,Ed.Dunod, (2006)

R.TAILLET,OptiquePhysique-Interférences,Diffraction,Holographie-Coursetexercicescorrigés,Ed. Debœck, (2006).

H.GAGNAIRE**,***Optique géométriqueetphysique*,Ed. Casteilla, (2011).

Semester :3

Methodology Teaching Unit

Teaching objectives

- Consolidation of theoretical knowledge on Vibrations and Waves.

- Learning and visualization of phenomena related to optics.

Recommended background knowledge

It is recommended to master the subjects " Phys. 1 & 2 " and " TP Phys. 1 & 2 " taught in 1st year Sciences of the Matter.

Subject Content:

1- Transverse oscillations of vibrating strings.
2- Electromechanical systems (the electrodynamic loudspeaker).
3- Damped oscillations (RLC circuit in free and forced oscillations).
4- Coupled oscillations: study of beats.
5- Coupled oscillations: study of natural frequencies.
6- Longitudinal wave propagation in a fluid.
7- Rheographic tank
8- KUNDT tube.
9- Induction phenomena

Evaluatingmode: Continuous: 50% Exam:50%

References (Books and handouts, websites, etc) :

T.BECHERRAWY,*Vibrations etOndes,*Tomes1-4, Ed.Hermes-Lavoisier,(2010).

H.DJELOUAH,Vibrationset OndesMécaniques,OPU, (2011).

J.BRUNEAUX,*Vibrations et Ondes,*Ed.Marketing, (2010).

Semester:3

Methodology Teaching Unit

Subject : Practical work on Geometrical Optics & Physics

Teaching objectives

- Consolidation of theoretical knowledge on geometrical and physical optics.

- Learning and visualization of phenomena related to optics.

Recommended background knowledge

It is recommended to master the subjects " Phys. 1 & 2 " and " TP Phys. 1 & 2 " taught in 1st year Sciences of the Matter

Subject Content:

1- Introduction: the different sources and detectors of light.

2- Reflection (plane mirror, spherical mirror) and refraction (air/glass, glass/air). 3- Study of the prism: deflection.

4- Study of the prism: dispersion. 5- Study of the grating: dispersion.

6- Prism spectroscope, grating spectroscope.

7- Focometry (determination of the focal length of a lens). 8- Microscope.

9- Polarization of light (rectilinear, circular, elliptical). 10- Reflection of a plane M.E.O. on a slide.

11- Spectrophotometry (transmission of different optical filters).

12- Interferometry (determination of the wavelength, of the index of a blade with parallel face, of the speed).

13- Diffraction (slits and gratings: Bragg's law, monochromator).

Evaluatingmode: Continuous: 50% Exam:50%

References (Books and handouts, websites, etc) :

F.WELL,OptiquePhysique - Cours : Propagation de lalumière, Ed. Ellipses, (2005)

H.GAGNAIRE**,***Optique géométriqueetphysique*,Ed. Casteilla, (2011).

Semester : 3

UE : Fundamental

Subject : Numerical Methods and Programming

The mastery of numerical tools by teaching advanced programming languages on the one hand, and on the other hand, by teaching numerical methods for solving systems of algebraic equations.

Recommended background knowledge

It is recommended to master the subjects " computer science 1 & 2 " and " mathematics 1& 2" taught in the 1st year *Sciences of the Matter.*

Subject Content:

Chapter 1: Introduction to (or review of) computer programming languages

MATLAB and/or MATHEMATICA and/or FORTRAN and/or C++,

Chapter 2. numerical integration

2. 1 Trapezium method

2. 2 Simpson's method

Chapter 3: Numerical solution of non-linear equations

3. 1 Method of Bisection

3. 2 Newton's Method

Chapter 4: Numerical solution of ordinary differential equations

4. 1 Euler's Method

4. 2 Runge-Kutta Method

Chapter 5: Numerical Solution of Systems of Linear Equations

5. 1 Gauss's Method

5. 2 Gauss-Seidel method

Evaluatingmode:Continuous : 50% Exam : 50%.

References (Books and handouts, websites, etc) :

ForMATLAB

M.DJEBLI&H. DJELOUAH,*Initiationà MATLAB*, OPU, (2013).

R. DUKKIPATI, *MATLAB, an introduction with applications,* New Age InternationalPublishers, India, (2010).

C.WOODFORDandC.Phillips,*Numericalmethodswithworkedexamples:MATLABedition*,2nd Ed.Springe rLtd, (2013).

ForC etC++

C.DELANNOY,*''C++pourles programmeursC*'',6ème Ed.,Eyrolles,Paris, (2004).

C.CASTEYDE, ''Coursde C/C++'',Copyright, (2005).

ForFORTRAN

B.HAHN,'*'IntroductiontoFortran90forscientistsandengineers*'',CapetownUniversity,SouthAfrica, (1993).

Ph.D'Anfray,'*'Fortran77*'',UniversitéParisXIII, (1998).

P.CORDEetA.FOUILLOUX,*LangageFortran,Supportdecours*, IDRIS, (2010).

For numerical methods

F. JEDRZEIJEWSKI,*Introductionauxméthodesnumériques*,2ème Ed.,Springer,France,(2005).

J.HOFFMAN,*Numericalmethodsforengineersandscientists*,2nd Ed,MarcelDekker,USA,(2001).

A. QUARTERONI,Méthodesnumériques, algorithmes, analyseetappl.,Springer,Italie,(2004).

Semester : 3

Discovery teaching unit

Teaching objectives

The teaching of this subject allows the student to discover the field of randomness and probability as well as the estimation and analysis of experimental or numerical data.

Recommended background knowledge

It is recommended to master the subjects " mathematics 1 & 2 " taught in 1st yearSciences of the Matter.

Subject Content:

Chapter 1: Basic elements of probability theory (2 weeks)

I. History and motivations (usefulness of probability in physics)

II. Basic axiomatics.

1. Probabilized space. Universe, tribe, probabilities, conditional probabilities.

2. Random variables. Definitions. Usual laws. Entropy. Functions of random variables. Systems of random variables. Conditional expectation.

Chapter 2: Convergences and limit theorems (2 weeks)

1. An example: "Variations around the coin toss".

2. Convergences. Law of large numbers (strong and weak). Central limit theorem.

3. Fundamental inequalities. Chebychev, Jensen, Hölder.

4. Large deviations. Links with the thermodynamic limit in statistical physics.

Chapter 3: Analysis of statistical series (3 weeks)

1. Single series. Double series.

2. Regression and correlation analysis: Simple and multiple linear regressions. Non-linear regression (exponential, logarithmic, polynomial).

Chapter 4: Inferential Statistics (4 weeks)

1- Parametric estimation

2- Statistical tests (correlation tests, independence tests, goodness-of-fit tests, Student's t test, ANOVA).

Chapter5: Data Analysis (3 weeks)

1-Principal component analysis (PCA). 2- Discriminant factor analysis (DFA).

3-Classification analysis (hierarchical, automatic).

Evaluating mode:Exam: 100%

Semester : 3

Discovery teaching unit

Teaching objectives

References (Books and handouts, websites, etc) :

FEMENIAS:Probabilités et statistiques pour les sciences physiques: Cours et exercices corrigés,Dunod,Paris,(2003).

SAPORTA,Probabilités, Analyse des Données et Statistique, 3ème Ed,Technip,Paris,(2011).

ESCOUBES, Probabilités et statistiques à l'usage des physiciens, Ed. Ellipses,Paris,(1998).

W.APPEL,Probabilités pour les non probabilistes, H&K Edition,Paris,(2013).

Semester : 3

Discovery teaching unit

Teaching objectives

The objectives to be achieved by teaching this subject are:

- The introduction of the concepts and properties of the crystal and the crystal lattice and the different lattice modes.

- Knowledge of the laws of diffraction and the different bonds in crystals.

Recommended background knowledge

It is recommended to master the fundamental basics of chemistry and physics from the first year of Science of the Matter

Subject Content:

I - Generalities

Definition of the crystalline state.

Lattices: definitions: row and lattice plane. Representative meshes. Pattern. Miller indices.

Reciprocal lattice: Definition: Some properties and relations with the size of the direct lattice. Inter lattice distance

II - Symmetry of finite figures

Symmetry operations : Inversion, Rotation, Reflection, Rotational inversion, Rotational reflection. Notions of equivalent points

III - Symmetry of networks - Bravais networks

Crystalline systems. The different modes of lattices. The fourteen Bravais lattices. Incompatibility of some orders of rotation axes with the lattices. Some geometrical relations in the lattices

IV - Experimental methods of diffraction

Conditions of diffraction. Bragg's law. Von Laue's equation. Ewald's construction. Different methods of diffraction: Laue method. Debye-Scherrer method. Method of the rotating crystal. Weissenberg method. Automatic diffractometers

V - Chemical bonds

Generalities on chemical bonds. Stable structures and internal energy. The different bonds in crystals : Forces of attraction, i) Strong bonds - valence bonds, Ionic bond. Covalent bond. Metallic bonding. Ii) Weak bonds - Van der Waals bond. Charge transfer bond. Hydrogen bonding. Repulsion forces

Evaluating mode:Exam :100%

References (Books and handouts, websites, etc) :

Semester : 3

Discovery teaching unit

Teaching objectives

With this subject the student will have discovered the fabulous world of physics and its history through time and the contribution of its scientists

Recommended background knowledge

Be familiar with the physical sciences of the first year SM

Subject Content:

1- Ancient physics

1.1 Origin of physics

1.2 Physics before Aristotle: Thales, Pythagoras, Empedocles

1.3 The atomists : Leucippus, Democritus...

1.4 Physics at the time of Aristotle: Theophrastus, Straton, Epicurus, Zeno

1.5 School of Alexandria & Physics: Euclid, Archimedes, Eratosthenes, Ptolemy

2- The contribution of the Islamic civilization to the evolution of physics

2.1 Contribution to the progress of astronomy (al-Khawarizmi, Habash al-Hasib, al-Battani, the brothers Banou Moussa, al-Sufi, ibn Yunus and al-Biruni, al-Zarqali)

2.2 Contribution to the progress of optics: al-Kindi, ibn Sahl, al Hazen

2.3 Contribution to progress on mechanics: (al Fārābi,, al-Khāzinī, al-Jāzāri, al-Baghdādī, al- Rāzī, al-Ṭūsī)

2.4 Contribution to the progress on the constitution of matter.

2.5 Contribution to the progress of magnetism.

3- Newtonian mechanics and electromagnetic theory

3.1 Copernicus, Kepler, Galileo, Newton

3.2 The 18th century: the triumph of mechanics: Christiaan Huygens, the brothers Jacques and Jean Bernoulli, Leonhard Euler, Jean Le Rondd'Alembert, Louis de Lagrange

3.3 The 19th century: electromagnetism: François Arago, Hans Christian Oersted, Michael Faraday, James Clerk Maxwell

3.4 Optics: from a corpuscular vision to a wave vision.

3.5 The crisis around 1900.

4- Quantum mechanics

Semester : 3

Discovery teaching unit

4.1 Planck's constant

4.2 Schrödinger and his equation

4.3 Heisenberg and the uncertainty relation

4.4 Pauli and the exclusion principle

4.5 The Bohr atom

4.6 Dirac and his contributions to quantum physics

5- The theory of relativity

5.1 The theory of special relativity; The mass-energy equivalence

5.2 Application: nuclear energy (fission, fusion)

5.3 The theory of general relativity; The curvature of space-time

5.4 Application : Expansion of the universe, standard model of cosmology

Evaluating mode: Exam: 100%

References (Books and handouts, websites, etc) :

J. ROSMORDUC, *Une histoire de la physique et de la chimie*, Le Seuil, coll.« Points Sciences», (1985).

A.DJEBBARetJ. ROSMORDUC, Une histoire de la science arabe: Introduction à la connaissance du patrimoine scientifique des pays d'islam,Le Seuil,(2001).

R. TATON, *Histoire générale des sciences*, PUF Quadrige,(1983).

M.BIEZUNSKI,*Histoire de la physique moderne*, la Découverte. (1993)

R.LOCQUENEUX, *Histoire de la physique*, P.U.F.Que sais-je?n°421, (1987)

M.PATY,*La physique du XXe siècle*,Vuibert, (1996).

Semester : 3

Subject : Inorganic Chemistry

Teaching objectives

The teaching of this subject allows the student physicist to acquire the knowledge and the fundamental laws of mineral chemistry

Recommended background knowledge

Know the physical sciences of the first year Science of Matter.

Subject Content:

- **Periodic properties**: blocks, periods, groups - Periodicity physical and chemical properties, characteristics of metals, non-metals and metalloids. Complements on the solid state.
- **Alkali and alkaline earth metals**, metals of groups IIIa and IVa, halogens, oxygen and sulfur, nitrogen and phosphorus.
- **Transition metals**: properties, coordination compounds, nomenclature, isomerism, hybrid orbital theories, crystal field theory, molecular orbital theory, magnetic properties and colors. The elements of groups IB, IIB, IIIB, VIIIB, rare earths.
- **Equilibria in solution:** Homogeneous and heterogeneous equilibria. Equilibrium constant. Equilibriumfactors. Le CHATELIER'sprinciple. General notions about solutions.
- **Solubility.** Parameters influencing solubility. Thermochemical aspect of solubility. Ionic dissociation and solvation.
- **Ionic solutions**. Acids and Bases: Ionic dissociation (The dissociation equilibrium (The auto - ionization of water.) Ionic product of water. Generalities of acids and bases (Definitions. Consequences of the BRONSTED definition. Forces of acids and bases). The pH of acids and bases. The concept of pH. Calculation of the pH of an acid or a base. Measurement of the pH. Neutralization of an acid by a base. Strength of acids and bases. Acido Basic properties - Concept of pH
- **Salts in solution**. Study of poorly soluble salts (Definitions. Solubility of salts. Solubility products. Displacement of the solubility equilibrium).
- Oxidation-reduction: Notion of degree of oxidation -Reactions.

Evaluating mode: Exam:100%

References (Books and handouts, websites, etc) :

Semester :3

Transversale Teaching Unit

Subject: Foreign Languages 3

Teaching objectives

Acquisition of a culture of scientific language and the basics of everyday language

- Acquisition of oral presentation skills.

Recommended background knowledge

It is recommended to have followed the subjects Foreign Languages 1 and 2, taught in L1 SM

Subject Content:

Oral and written expression, communication and methodology in foreign language Training in the comprehension of written documents related to the field of physics. An attempt will be made to combine language teaching with scientific training as much as possible. All media will be used

- Translation of notices and publications; Writing of summaries; Bibliography and project presentations.

Evaluating mode:Exam : 100%

References (Books and handouts, websites, etc) :

Semester :4

Fondamentale Teaching Unit

Teaching objectives

Among the fundamental branches of physics, the teaching of this subject allows the student to acquire the fundamental laws of thermodynamics and the conservation of energy as well as the thermodynamic or state functions characterizing a system and irreversibility.

Recommended background knowledge

it is recommended to master the subject "Chemistry 2" taught in S2 of the 1st year Sciences of the Matter.

Subject Content:

Chapter 1 - Reminder of the principles of thermodynamics:

Recall of basic concepts: microscopic and macroscopic descriptions; work, heat, internal energy; principle of conservation of energy; definition of thermal equilibrium.

Recall the principles of thermodynamics.

Chapter 2 - Notions on the modes of heat transfer: Conduction, convection, thermal radiation.

Chapter 3- Principle of maximum entropy:

Internal constraints; maximum entropy principle; thermodynamic variables: temperature, pressure, chemical potential, ... quasi-static and reversible transformations; maximum work and thermal machines.

Chapter 4- Elements of kinetic theory and irreversible phenomena

effective cross-section, time of flight, mean free path; temperature, pressure; examples of irreversible physical laws; approximation of the mean free path, thermal conductivity, diffusion coefficient.

Chapter 5- Thermodynamic Functions

Choice of thermodynamic variables; thermodynamic potentials; heat capacities; Gibbs-Duhem relation.

Chapter 6- Chemical Potential

Fundamental relationships; coexistence of phases; equilibrium conditions at constant pressure; equilibrium and stability at fixed chemical potential; chemical reactions.

Chapter 7- Applications:

Thermal machines: ideal thermal machines; real thermal machines; liquefaction of gases; techniques for obtaining low temperatures.

Phase transitions of a pure substance; phase transitions of a mixture; dilute solutions; chemical equilibrium.

Thermodynamics of magnetic materials: macroscopic approach; microscopic model and analytical solution.

Semester :4

Fondamentale Teaching Unit

Teaching objectives

Evaluating mode: Continuous:33%Exam:67%

References (Books and handouts, websites, etc) :

B.DIUet al,*Thermodynamique*, Editions Hermann, Paris, (2007).

B.DIUet al, *Exercices et problèmes de thermodynamique*, Editions Hermann,Paris, (2010).

J.P.PEREZ,Thermodynamique:Fondementsetapplications,Exercicesetproblèmes,Dunod,Paris, (2001).

M.LE BELLAC et al, *Thermodynamique statistique*, Dunod, Paris, (2001).

W.GREINERetal,*Thermodynamique et mécanique statistique*,Springer, Paris, (1999).

J-N.FOUSSARD,S.MATHE,*Thermodynamique-Bases et applications,Cours et exercices corrigés*,2ème Ed.Dunod, (2010)

R.MAUDUIT,*Thermodynamique en 20 fiches*, Ed.Dunod,(2013)

Semester :4

Fondamentale Teaching Unit

Teaching objectives

Mathematics dealing with the complex variable is very important at this level of university education. They deal with elementary functions and holomorphism of functions, with residue theorems and their applications.

Recommended background knowledge

It is recommended to master the subjects " Mathematics 1 & 2 " taught in 1st year Sciences of the Matter.

Subject Content:

Chapter 1: Holomorphic Functions

The complex plane - Functions of a complex variable with complex values - Holomorphic and harmonic functions - Holomorphic transformations - Primitive of a holomorphic function.

Chapter 2: Elementary functions

Homographic function - Exponential, trigonometric and hyperbolic functions - Logarithm function - Power functions - Trigonometric and hyperbolic inverse functions.

Chapter 3: Fundamental Theorems about Holomorphic Functions

Integral along a path, an arc of a curve - Cauchy's theorem - Primitives - Cauchy's integral - Taylor series - Study of zeros - Analytical extension - Laurent development - Isolated singular points.

Chapter 4: Residue theorems and applications to the calculation of integrals

Residue theorem - Integrals of rational fractions - Trigonometric integrals - Multiform functions, formula of complements - Residue at infinity.

Chapter 5: Applications

Equivalence between holomorphy and analyticity. Maximum theorem. Liouville's theorem. Rouché's theorem. Residue theorem. Computation of integrals by the Residue method.

Evaluating mode: Continuous:33%Exam:67%

References (Books and handouts, websites, etc) :

SPIEGEL, *Variables complexes, Cours et problèmes,* Séries Schaum, MacGrawHill,(2000).

ElieBELORIZKY, Outils mathématiques à l'usage des scientifiques et des ingénieurs, EDP Sciences,Paris, (2007).

WalterAPPEL, *Mathématiques pour la physique et les physiciens*!,4ème Ed.,H&K Edition, Paris,(2008).

Semester :4

Fondamentale Teaching Unit

Teaching objectives

C.ASLANGUL, Des mathématiques pour les sciences1,Concepts,méthodeset techniques

Pour la modélisation, DeBoeck,Bruxelles(2011).

C.ASLANGUL, *Des mathématiques pour les sciences2*, Corrigés détaillés et commentés des exercices et problèmes,DeBoeck, Bruxelles(2013).

Semester :4

Fondamentale Teaching Unit

Teaching objectives

Being the basis of theoretical physics, quantum mechanics is built on the mathematical formalism and postulates of quantum mechanics for the explanation of quantum phenomena and the description of elementary particles.

Recommended background knowledge

It is recommended to master the Mathematics and Physics of the 1st year SM, as well as the subject "Analytical Mechanics" taught in S3, SM.

Subject Content:

Chapter 1: Introduction to quantum phenomena

Black body radiation and Planck's hypothesis. The photoelectric effect. The Compton effect. The de Broglie hypothesis and the wave-corpuscle duality. The Franck & Hertz experiment and the quantization of energy.

Chapter 2. The description of particles in quantum mechanics

The notion of wave function and the probabilistic description of physical systems. Density of presence probability and normalization condition. Mean value and root mean square deviation of the position and the momentum. Measurement and uncertainty in the measurement of position and momentum. Heisenberg's uncertainty principle.

Chapter 3. The Schrödinger equation and study of elementary potentials in one dimension

The Schrödinger equation and its properties. Form of the stationary solutions. Study of the case of the free particle enclosed in a box of finite volume. Study of the potential well of infinite depth. Study of the walk and the square potential barrier. Reflection and transmission coefficients, tunneling effect.

Chapter 4. The mathematical formalism of quantum mechanics

Hilbert space, spaces of wave functions, space of states. Dirac notation, linear operators, hermetic operators. Eigenvalue equations, observables, Ecco. Representation x and p tensor product of spaces and operators

Chapter 5. The postulates of quantum mechanics

Description of the state of a system and of physical quantities. Measurements of physical quantities. Temporal evolution of systems. Mean value of an observable, mean square deviation. Evolution of the mean value of an observable, Ernest's theorem. Conservative systems, Bohr frequency. Time-energy uncertainty relation

Chapter 6. A small introduction to the study of the harmonic oscillator

Evaluating mode: Continuous: 33%Exam:67%

Semester :4

Fondamentale Teaching Unit

Teaching objectives

References (Books and handouts, websites, etc) :

C.COHEN-TANNOUDJI,B. Diu et F.Laloë, *Mécanique quantique,* Hermann, (1997).

C.PIRON; *Mécanique Quantique: Bases et Applications,* Presses Polytechniques et Universitaires Romandes, (1998).

L. LANDAUet E.LIFCHITZ,*Physique théorique, tome3:Mécanique quantique,* éd.MIR,Moscou,(1975).

A. TELLEZ-ARENAS, Mécanique quantique:Travaux dirigées, Masson, (1976).

R.OMNES;*Les indispensables de la mécanique quantique*,Collection Sciences, OdileJacob,(2006).

Semester :4

Fondamentale Teaching Unit

Teaching objectives

Electromagnetism is essential for a physicist and will be presented through the magnetic field and its Maxwell and Lorentz models as well as radiation and the propagation of electromagnetic waves.

Recommended background knowledge

It is recommended to master the subject Physics 2 (Electricity) taught in S2 and Mathematics, of the 1st year Science of the Matter

Subject Content:

Chapter 1: Mathematical Tools

1.1 Vector analysis relations (Gradient, divergence, Rotational and Laplacian) in Cartesian, polar, cylindrical and spherical coordinates.

1.2 Definition and Properties of the Dirac Delta Distribution.

Chapter 2: Maxwell's Equations

2.1 Reminder of the basic notions: Electric field, Magnetic field, Scalar potential V and vector potential A, Lorentz conditions. Lorentz force.

2.2 Maxwell's equations

Chapter 3 : Propagation of electromagnetic waves

3.2 Plane waves in an infinite medium: plane waves in vacuum. Propagation of electromagnetic plane waves in insulators, in a conducting medium, in ionized gases at low pressure.

3.3 Reflection and refraction: Laws of reflection and refraction. Fresnel equations. Brewster's angle. Total reflection on an interface between two magnetic insulators. Reflection and refraction at the surface of a good conductor. Reflection of an electromagnetic wave by an ionized gas.

3.4 Guided waves: Straight line propagation, coaxial line, rectangular and hollow waveguides.

Chapter 4: Radiation of Electromagnetic Waves

4.1 Radiation of an Electric Dipole.

4.2 Radiation of an antenna, antenna alignment.

4.3 Radiation of an Electric Quadrupole.

4.4 Radiation of a Magnetic Dipole.

4.5 Radiation of a Magnetic Quadrupole.

4.6 Reciprocity Theorem.

Evaluating mode: Continuous:33% Exam:67%

Semester :4

Fondamentale Teaching Unit

Teaching objectives

References (Books and handouts, websites, etc) :

J.-P.PEREZ,R.CARLES,R.FLECKINGER**,**Electromagnétisme Fondements et Applications, Ed.Dunod, (2011).

H.DJELOUAH, *Electromagnétisme,* Offices des Publications Universitaires OPU, (2011).

Semester:4

Methodology Teaching Unit

Teaching objectives

- Consolidation of theoretical knowledge on thermodynamics.

- Learning and visualization of phenomena related to thermodynamics.

Recommended background knowledge

It is recommended to master the subjects " Chemistry 2 " and " TP Chimie2 " taught in S2 as well as Mathematics, of the 1st year, Science of the Matter.

Subject Content: (Choose 5 TP according to availability of material)

1- Law of perfect gases: verification of Boyle-Mariotte's law

Materials(*): Graduated glass tubes (Ø = 1.5 cm approx.) with tap, flexible tube, large ruler, mercury and supports.

2- **Measurement of the coefficient γ = Cp/Cv**: determination by the Clément-Désormés method Materials: carboy with tap, glass tubes (Ø= 3-5mm), flexible tubes, air pumps, U-shaped glass tubes, chronometer, mercury, large graduated ruler, taps and supports.

3- Thermal expansion of solids

Materials: Tubes (steel, brass, copper, glass,...) L=65cm and Ø= 7mm, dial pyrometer, comparator, digital thermometers, flexible tubing and circulating thermostat from 30 to 100°C

4- Calorimetry: Measure heat quantities or heat transfers between different bodies using several types of calorimetry (ice, resistance,...) Materials: Dewar's vase with lid, copper, lead, glass shot... (approx. 100 g of each), thermometers, balance, steam generator 220V/550W, beaker, calorimeter, heating set with cover and accessories, aluminium beaker, Bunsen burner, ice and supports.

5- Determination of the latent heat of vaporization

Materials: Apparatus to determine the pressure of water vapor (boiler), a 60 atm manometer, a 0-250°C thermometer and a gas burner (Bunsen burner)

6- Calibration of a thermocouple (measurement of its thermoelectric power)

Materials: Wire (copper and constantine), two beakers, thermometers (0-100°C), digital microvoltmeter, gas burner, ice and a candle.

7- Heat propagation in a cylindrical metal bar

Materials: Metal tubes l = 1.5 m and Ø =2 cm, digital thermometers, stopwatch, tubular oven and supports.

8- Heat transport: thermal convection

Materials: Thermosiphon, Bunsen burner, powdered dye and supports.

Semester:4

Methodology Teaching Unit

Teaching objectives

9- Thermal insulation

Materials: Heat chamber with accessories.

10- Kinetic theory of gases: variation of the volume of gases as a function of pressure at constant temperature (Boyle-Mariotte law).

(*) For information only.

Evaluating mode: Continuous:50% Exam:50%

References (Books and handouts, websites, etc) :

B.DIUet al, *Thermodynamique* ,Editions Hermann, Paris, (2007).

M.LE BELLAC et al, *Thermodynamique statistique*,Dunod, Paris, (2001).

Semester :4

Methodology teaching Unit

Teaching objectives

This course provides the student with the fundamentals of Fluid Mechanics starting with: fluid statics, then kinematics and finally the dynamics of fluids whether perfect or viscous. This course is accompanied by practical work.

Recommended background knowledge

It is necessary to master the subject "Physics 1" as well as the mathematics of the 1st year SM.

Subject Content:

Chapter 1 : Generalities

Definition of a continuous medium, characteristics of a fluid medium, notion of a fluid particle. Volume forces and surface forces applied to a fluid domain. Perfect fluid, viscous fluid.

Chapter 2: Fluid Static

General equation of fluid statics. Special case of hydrostatics. Buoyancy forces. Static of gases.

Chapter 3: Kinematics of fluids

Location of a fluid particle. Lagrange's point of view, Euler's point of view, particle derivative. Current lines, emission lines, trajectory. Tensor of deformations behavior laws. Case of a Newtonian fluid. Rotational and irrotational flows. Plane flows with velocity potential: classical example.

Chapter 4: Perfect Fluid Dynamics

General theorems. Fundamental equations for a perfect fluid. Bernoulli equation: applications. Study of flow meters (venture, Pitot tube...).

Chapter 5: Viscous Fluid Dynamics

Integral equation of motion. Local equation, Navier-Stockes equation, applications Resolution of some classical unsteady problems.

Chapter 6: Introduction to gas dynamics

St-Venant's barred equation. Flow in a convergent-divergent. Supersonic flow, shock waves.

List of the MDF TPs (Do 5 TPs according to the material available)

1. Demonstration and measurement of surface tension.
2. Archimedean thrust
3. Measurement of viscosity
4. Flowmetering
5. Pressure and speed measurement (Pitot tube). Accuracy of manometers

Semester :4

Methodology teaching Unit

Teaching objectives

6. Haguen-Poiseuille flow and emptying a tank (Torricelli)
7. Regular pressure losses and verification of Bernoulli's theorem
8. Singular pressure losses in a conical widening and narrowing
9. Study of a rotameter and deduction of the frictional force on the ludion (drag)
10. Action of a jet on a plane obstacle (momentum theorem).

Evaluating mode: Continuous:50%Exam:50%

References (Books and handouts, websites, etc) :

S.CANDEL,Mécanique des Fluides(tomes1 et2 cours et problèmes résolus, Dunod, (1995).

R.K.ZEYTOUNIAN**,** *Mécanique des fluides fondamentale,* Springer-Verlag,Berlin, (1991).

R.BENHAMOUDA**,** Mécanique des fluides-(Cours et exercices corrigés)**,** OPU, (2008)

R.V. GILES,J.EVETT,C.LIU.*Mécanique des fluides et hydraulique,*McGraw-Hill,Paris,(1995)

H.BROCHI**,** *Mécanique des fluides,* Ed. Université Nice Sophia-Antipolis, (2006).

J.COIRIER, Mécanique des milieux continus. Concepts de base,Dunod, Paris, (1997).

, Mécanique des fluides et hydraulique (courset problèmes), SérieS CHAUM

Mastery and calculation of electrical networks and circuits of the RL, RC and RLC types as well as quadrupoles and diodes accompanied by a set of application examples in the form of practical work.

Recommended background knowledge

It is recommended to master the subject Physics 2 (Electricity) taught in S2 and Mathematics, of the 1st year Science of the Matter

Subject Content:

I - ELECTRICAL NETWORKS (5 weeks)

1.Direct current: Definition, voltage and current generators (ideal, real), voltage-current relationships (R, L, C), Kirchhoff's laws. Linear network analysis methods: mesh and node method, application to matrix notation. Fundamental theorems (superposition, Thevenin and Norton theorems, reciprocity), equivalence between Thevenin and Norton.

2.Variable regime: Circuits and signals in variable regime, application of variational calculus (Laplace transform, example: symbolic impedance and circuits with a step signal or pulse signal).

3.Sinusoidal regime: representation of signals, complex notations, electrical impedance, adaptation of a sinusoidal generator. Methods of network analysis in sinusoidal regime and fundamental theorems, application to RC, RL circuits.

4.Study of series and parallel resonant circuits, forced regime: frequency responses, quality coefficients, bandwidth, selectivity, logarithmic units.

5.Study of RLC circuits in free regime: the different regimes, initial conditions. RC and RL circuits (maximum energy in C and L).

II - PASSIVE QUADRIPOLES (6 weeks)

1.Representation of a passive network by a quadripole: The matrices of a quadripole, association of quadripoles. Quantities characterizing the behavior of a quadripole in a circuit (input and output impedance, current and voltage gain), application to matching.

2.Particular passive quadrupoles: In Γ, T, Π, etc. star - triangle equivalence. Passive electrical filters: image and characteristic impedances, study of the gain (in attenuation) of a filter loaded by its iterative impedance. Special case of the symmetrical ideal filter (bandwidth). Representation of transfer functions (Bode curves). Transformers, magnetically coupled circuits: free regime (beat) forced regime (different flow and frequency responses, bandwidth).

III - DIODES (4 weeks)

Basic notions of semiconductor physics: intrinsic and extrinsic semiconductors. Conduction, doping, pn junction, energy diagram.

Constitution and operation of a diode: polarization, I(V) characteristic, static charge line, variable regime.

Diode circuits: full and half wave rectification, application to voltage stability by the Zener diode, clipping. Other types of diodes: varicap, LED, photodiode.

List of electronics 1 practical exercises (do 5 according to the material available)

1- Fundamental theorems (superposition, Thévenin, Norton).

2- Circuits in free regime : Integrator and derivator

3- Resistive quadrupoles.

4- Passive filters: T-filters, double T-filters, influence of the load, response curve, Bode diagram for second order circuits.

5- Active filters.

6- Diode I (diode characteristics, rectification and filtering).

7- Diode II (Zeener diode, stabilization by Zeener diode, full wave rectification by bridge, clipping).

Evaluating mode: Continuous:50% Exam:50%

References (Books and handouts, websites, etc) :

Semester:4

Discovery Teaching Unit

Teaching objectives

A wonderful branch of physics, the teaching of this subject allows the student to discover the infinitely small and understand physics at the scale of the atom and the nucleus

Recommended background knowledge

It is recommended to master the Physics and Chemistry subjects (S1+S2) of the 1st year Science of the Matter.

Subject Content:

A- Atomic physics Introduction

Chapter 1: Duality waves - corpuscle

Wave properties of matter. Wave function. Heisenberg's uncertainty relations.

Chapter 2: Introduction to atomic spectroscopy

Spectra. Energy levels

Chapter 3. Hydrogen atoms and hydrogen atoms Bohr's theory. Sommerfeld's theory. Quantum study

Chapter 4. Atoms with several electrons

Chapter 5. Atomic Spectroscopy

Radiative Transitions. Spontaneous emission. Induced Emission

Chapter 6. X-rays Mosley's law. Spectra

B- Nuclear Physics :

Chapter 7. Basic concepts

Chapter 8. Structure of the nucleus

Chapter 9. Radioactive decay

Chapter 10. Nuclear reactions

Evaluating mode: Exam :100%

References(Books and handouts, websites, etc) :

Semester :4

Discovery Teaching Unit

Teaching objectives

The objectives of the teaching of this subject are to introduce the student to the infinitely large at the galactic scale and that of the solar system, planets and stars.

Recommended background knowledge

It is recommended to master the Physics and Chemistry subjects (S1+S2) of the 1st

year Science of the Matter.

Subject Content:

Chapter 1: Observation and measurement

Units of measurement in astronomy. Evolution of the instruments of measurement and observation.

Chapter 2. The solar system

Ptolemy's geocentric and Copernicus' heliocentric systems. Measurements of the mass, size and age of the sun and planets. Atmospheres, magnetic fields and compositions of the planets.

Chapter 3. The stars

Optical characteristics: brightness, color, spectrum. Evolution of stars: birth, life, death and nucleosynthesis. Characteristics of our galaxy: the Milky Way. Novae, supernova, pulsar and black holes.

Chapter 4. Cosmology

The great structures of the universe. The cosmological background and the theory of the expansion of the universe. The cosmological model of the Big-Bang.

Evaluating mode:Exam :100%

References (Books and handouts, websites, etc) :

A. Acker, *Astronomie*, Masson,(1992)

L. Botinelli etal. *La Terre et l'Univers*, Synapses, Hachette,(1993)

J.Y. Daniel et coll., *Sciences de la Terre et de l'Univers*, Vuibert, (2000)

T.Encrenazet J.P.Bibring, *Le système solaire*, Inter éditions CNRS,(1987)

M.Lachièze-Rey, *Initiation à la cosmologie*, Dunod,(2000)

E. Schatzmanet F.Praderie, *Les étoiles*, Inter éditions CNRS,(1990)

D. Benest, *Les planètes*, Points Sciences Le Seuil,(1996)

T.Encrenaz,*Le système solaire*, Dominos Flammarion,(1994)

Semester :4

Discovery Teaching Unit

Teaching objectives

A. Blanchard, Histoire et géographie de l'univers, Belin(2000)

M.Mayor et P.Y.Frei, *Les nouveaux mondes du cosmos*, Le Seuil,(2000)

D. Proustet J.Breysacher, *Les étoiles*, Points Sciences, Le Seuil,(1996)

D. Proustet C.Vanderriest,*Les galaxies*, Points Sciences, Le Seuil, (1997)

Semester :4

Discovery Teaching Unit

Teaching objectives

The teaching of this subject allows the student to understand wave-corpuscle duality, atomic spectroscopy and induced reactions.

Recommended background knowledge

It is recommended to master the Physics and Chemistry subjects (S1+S2) of the 1st

year Science of the Matter.

Subject Content:

Chapter 1 Duality wave - corpuscle

Black body. Photo electric effect. Compton effect. De Broglie waves.

Chapter 2 The planetary model Hydrogen atom (Bohr- Sommerfeld)

Chapter 3 Atomic spectroscopy

Ionization potential. Excitation potential. Excited state of the atom. Atomic spectra. Ritz combination principle. Line widths. Displacement. Heisenberg uncertainty principle. Lifetime.

Chapter 4. Atoms with several electrons

Angular momentum and layer filling. Case of the Helium atom. Case of the alkaline atom.

Chapter 5. Induced absorption and emission

Laser effect

Chapter 6. introduction to molecular physics

Diatomic Molecules A-B. Rotation. Vibration. Coupling rotation-vibration.

Evaluating mode:Exam :100%

References (Books and handouts, websites, etc) :

Semester :4

Discovery Teaching Unit

Subject : Physical and chemical analysis techniques

Teaching objective

With this subject the student will have discovered the techniques of physico-chemical analysis using atomic absorption spectrophotometers, infrared spectrometers, NMR spectroscopes and mass spectrometers.

Recommended background knowledge

It is recommended to master the subjects of Physics and Chemistry (S1+S2) of the 1st year Science of the Matter and the subjects of "Geometric Optics and Physics" (courses, TD) & TP taught in S3 of the 2nd year SM.

Subject Content:

Chapter 1: Introduction to spectral methods: definition and generalities on electromagnetic spectra.

Chapter 2. Absorption laws and application of BEER LAMBERT's law to UV-Visible spectrophotometry: principle. Different absorption domains. Different chromophores. Application in quantitative analysis.

Chapter 3: Atomic absorption spectrophotometry: Principle and theory. Instrumentation. Characteristics of a flame. Atomization furnace. Interferences. Applications.

Chapter 4: Infrared spectrometry: Presentation of the mid-infrared spectrum. Origin of absorptions in the mid-infrared. Vibration-rotation bands of the mid-infrared. Simplified model of vibrational interactions. Characteristic bands of organic compounds. Instrumentation. Comparison of spectra.

Chapter 5. Nuclear Magnetic Resonance Spectroscopy: Generalities. Spin/magnetic field interaction for a nucleus. Nuclei that can be studied by NMR. Bloch's theory for a nucleus with I=1/2. The principle of obtaining the spectrum by NMR. The NMR of hydrogen. The chemical shift. Shielded and unshielded nuclei. Hyperfine structure. Spin-spin coupling.

Chapter 6. Mass spectrometry :

Principle of the method. Ion deflection - Bainbridge spectrum. Performance of mass spectrometers. The different analyzers

Evaluating mode:Exam : 100%

References (Books and handouts, websites, etc) :

Semester :4

Subject:Foreign Languages 4

Teaching objectives

This unit is a continuation of the subject " foreign language 3 of Semester 3 : Oral and written expression, communication and methodology

The objectives are :

- Active participation of the student in his/her own training.

- Introduction to communication techniques.

- Introduction to bibliographic research techniques.

Recommended background knowledge

It is recommended to have followed the Foreign Languages 3 subjects taught inS3.

Subject Content:

- Learning to write and present a given study of general culture.

- Introduction to internet research techniques.

(We will try as much as possible to associate language teaching with scientific training and all media will be used).

Evaluating mode:Exam :100%

References (Books and handouts, websites, etc) :

III - Detailed program by subject for semesters S5 and S6

(1 detailedsheet per subject)

(All fields must be filled in)

Semester : 5

Fundamental TU

Subject : Quantum Mechanics II

Credits : 6

Coefficient : 3

Teaching objectives:

The objective of this module is to update and deepen the knowledge in quantum mechanics acquired in S4.

Recommended prior knowledge

Quantum mechanics I, Series and differential equations

Content of the course:

Chapter 1:

Recalls Postulates of quantum mechanics.

Chapter2:

Kinetic moments General theory Orbital kinetic moments, spherical harmonics ½ spin kinetic moment Composition of kinetic moments. Clebsh-Gordon coefficients.

Chapter 3:

The central potential Bound states.

Hydrogen atom Diffusion states Variational method.

Chapter 4:

Approximation methods Stationary perturbations: non-degenerate case Stationary perturbations: degenerate case

Chapter 5 :

Elastic scattering by a central potential The experiment and the effective section

Scattering states and scattering amplitude Partial wave method: the phase shift

The optical theorem Scattering matrix and Born approximation

Evaluation method : Continuous : 33% Exam : 67

References:

- *Mécanique quantique I-II,*CohenTannoudjiC,HermannParis,1977.

- Mécaniquequantiqueetapplicationàl'étudedelastructuredelamatière,BlokhintsevD
  I,Masson
  Paris,1967.
- Mécaniquequantique:tome2théoriedesperturbations,mécaniquequantiquerelativiste,SalmonJ,
Masson Paris,1967.
- Mécaniquequantique:tome1équationsdeSchrödingerapplications**,**Salmon
  J,Masson Paris,1967.
- *Mécanique quantiqueI-II*,J.L.Basdevant,Presses de l'Ecole Polytechnique,1985.
- *Mécanique quantique*,L.LandauetE.Lifchitz,Ed.Mir(1974).
- *Mécanique quantiqueT2*,Messiah,ed.Dunod,Paris(1972).
- Mécanique quantique: atomes et molécules, HladikJ,MassonParis,1997.
- Principes de mécanique quantique, BlokhintsevD,MirMoscou,1981.
- Problèmes de mécanique quantique, BasdevantJL,Ellipses,Paris,1996.
- Théorie quantique des champs,DerendingerJP,PPURLausanne2001.
- Théorie quantique du solide, Kittel C,DunodParis1967.

Semester : 5

Fundamental TU

Subject : Statistical Physics

Credits : 6

Coefficient : 3

Objectives of the course

To make the students acquire the use of statistical methods in physics, to familiarize them with the notions of discernible and indistinguishable particles, macrostates and microstates.

To study Gibbs sets and some applications: modeling of physical systems, quantum studies, classical limit.

Recommended prior knowledge

Thermodynamics course, acquired in S4

Content of the course:

Chapter 1: Basic elements:

Introduction to statistical methods: random walk, averages and standard deviations Discernible and indiscernible particles, N-particle systems, microstates, macrostates Classical microstates, phase space Basic postulate Ergodic hypothesis

Chapter 2: Microchannel ensemble: Equiprobability of microscopic states of an isolated system. Statistical entropy. Gibbs' paradox. Thermodynamic limit. Link with the second principle of thermodynamics.

Chapter 3: Canonical set: Boltzmann factor.

Partition function and free energy. Average energy and fluctuations.

Equipartition theorem.

Applications to systems of particles without interactions.

Chapter 4: Canonical grand set: thermodynamic grand potential.

Bose-Einstein statistics. FermiDirac statistics.

Bose perfect gas.

Black body radiation.

Fermi perfect gas at zero temperature. Debye-Einstein model for phonons. Paramagnetism.

Chapter 5: Blackbody Radiation Applications

Evaluation method : Continuous : 33% Examination : 67

References:

- M.LeBellacetal: Thermodynamique statistique, Dunod(2001).
- W.Greineretal: Thermodynamique et mécanique statistique, Springer

Semester : 5
Fundamental TU
Subject : Special Relativity Credits : 4
Coefficient : 2
Teaching objectives:
After quantum mechanics, the student discovers the other great theory of the 20th century. Introduction of the concepts of inertial reference frame, four-dimensional space-time, light cone, quadrivector. Mass-energy equivalence, unification of electric and magnetic fields: electromagnetic field tensor. This module completes the study of electromagnetism**.**
Recommended prerequisites:
Physics1,2,3,4, Mathematics, Chemistry**.**

Content of the subject :

Chapter 1: History
Roles of the aether: propagation medium of E.M. waves and absolute reference frame. Experiments of Michelson & Morley.
Chapter 2: Relativistic kinematics
Postulates. Lorentz transformation: length contraction, time dilation. Transformation of velocities.
Application : Aberration of light. Minkowski universe. Cone of light. Quadrivectors. Eigentime.
Applications : Relativistic Doppler effect.
Chapter 3: Relativistic dynamics Reminders: Newtonian dynamics.
Impulse and Energy : Impulse-Energy quadrivector. Equations of relativistic dynamics.
Application to the photon. Mass-energy equivalence.
Interactions between particles. Compton effect. Cerenkov effect.
Chapter 4: Electromagnetism
Reminder of the laws of electromagnetism.
Invariance of the laws of electromagnetism: relationship between the potential and current quadric vectors. The electromagnetic field tensor.

Evaluation method: Continuous: 33% Exam: 67%.

References:-Hladik:IntroductionàlarelativitéRestreinte,2006,Dunod(Paris).
- Landau:Théorie des champs, EditionsMir(Moscou)
- Jackson:Electrodynamique Classique,2001, Dunod(Paris)
- DiBartolo:Classical Theory of Electromagnetism, 2nd Edition,2004, World Scientific(Singapore)
- Greiner: Classical Electrodynamics, Springer(Berlin)

- **Semester : 5**
- **UE : Fundamental**
- **Subject : Mathematical Methods for Physics**
- **Credits : 4**
- **Coefficient : 2**
- **Objectives of the course**
- The objective of the course Mathematical Methods for Physics is to present a certain number of mathematical methods necessary for a good training in physics. These are not "recipes" to be applied blindly, but mathematical tools which it is important to master**.**
-
- **Recommended prior knowledge:**
- Math1 + Math 2+ Math3+ Math4.
-
- **Content of the course :**
- **Chapter 1:** The beta and gamma Eulerian functions. Properties:
- -Stirling formula
- -duplication formula
- -complement formula
- - Logarithmic derivative of the gamma function. Incomplete gamma function**.**
- **Chapter2:**Bessel functions.
- Solving the Bessel differential equation
- Bessel functions of first kind, Neumann functions, Hankel functions of first and second kind.
- Recurrence relations
- -Integral form
- - Bessel functions of integer index, half integer index
- - Modified Bessel functions. Development in series of Bessel functions. Application of Bessel functions.
- **Chapter 3:** Error function and Fresnel integrals. Definition
- -Integral representation
- -Development in series
- -Asymptotic development.
- **Chapter 4**: Exponential integral, sine integral, cosine integral. Definition
- -Integral representation
- -Development in series
- -asymptotic development**.**
- **Chapter5:**Orthogonal polynomials. General properties-Recurrence formulas
- -Christoffel Darboux'sidentity
- - Zeros of orthogonal polynomials
- - Generating function
- - Legendre, Laguerre, Hermite, Chebyshev polynomials.
-
- Definitions, orthogonality, recurrence relations.
- Development of a function in series of orthogonal polynomials.
- **Chapter6:** Hypergeometric functions.
- - Solving hypergeometric and degenerate hypergeometric equations
- - Integral representation
- -Recurrence relations
- - Representation of some special functions using hypergeometric functions.

-
- **Evaluation method:**Continuous: 33% Exam: 67%.
-
- **Bibliographical references:**
- N.Piskounov.Ellipses Marketing1998.
  - V.Smirnov.Cours de mathématiques supérieures. Ed.Mir(Moscou)1979
  - Analysede Fourier,Série Schaum.
  - C.Tannoudji, Mécanique Quantique.

Semester : 5

Methodology TU

Subject : Physics of Semiconductors

Credits : 4

Coefficient : 2

Teaching objectives:

To give students the basic physical properties of semiconductor crystals and their behavior when subjected to an electrical potential difference.

Recommended Prerequisites:

Possess the physical basis for the study of the operation of electronic components**.**

Content of the subject:

1. **Definition of semiconductors.**
2. **Thermal diffusion of impurities.**
3. **Electron and hole statistics.**
4. **PN junction.**

Evaluation method: Continuous: 50% Exam: 50%.

References:

- Henry Mathieu,Hervé Fanet'Physique des semi-conducteurs et des composants électroniques'.Dunod (2009)
- Christian Ngo, HélèneNgo'Physique des semi-conducteurs'.Dunod(2012)

Semester : 5
UE : Methodology
Subject : Electromagnetic Waves

1. **Credits : 4**
2. **Coefficient : 2**
3. **Teaching objectives:**
   The content of this subject, following the laws of electromagnetism taught in S2 and S4, allows the student to acquire the notions relating to the propagation of electromagnetic waves in isotropic, anisotropic and in the various linear or guided media.

4. **Content of the course :**

   Chapter 1: Propagation of electromagnetic waves in different isotropic media (vacuum, dielectrics, conductors, plasmas...).

   Chapter 2: Propagation of electromagnetic waves in anisotropic media.

Chapter 3: Propagation of Electromagnetic Waves in Nonlinear Media.

   Chapter 4: Propagation of electromagnetic waves in guided media (linear waveguides, plane, cylindrical, hollow and optical fibers.

5. **Evaluation method : Continuous : 50% Exam : 50% References :**
E.Vauthey.Petiteintroductionàlaspectroscopieoptiquenon-linéaire,2008 Département de Chimie-Physique de l'Université de Genève,30 QuaiErnestAnsermet,CH-1211Genève4.
6. P.W.Smith&W.J. Tomlinson,«Bistable optical devices promise subpico second switching »,in IEEESpectrum,vol.XVIII,p.26,1981.
7. T.F.Heinz, H.W.K.Tom&Y.R.Shen,« Nonlinear optical probes of interfaces »,inLaserFocus,vol.XIX,no5,p.101,Newtonville(Mass.),1983.
8. N.Bloembergen.Nonlinear Optics ,Addison-Wesley,Redding(Ma.),1991.

- **Semester : 5**
- **UE : Methodology**
- **Subject : Experimental Methods**
- **Credits : 4**
- **Coefficient : 2**
- **Objectives of the course**
-
- **Introduction to the study of the nucleus**
- **Recommended prerequisites**
- Atomic physics, Quantum mechanics I, Math3
- **Content of the subject :**
-
- - Properties of ground states (masses; T1/2; quadrupole electric moments and deformations; dipole magnetic moments).
- - Decay studies (beta-n, beta-p correlations and structure studies, precision measurements and standard model tests).
- - Reaction studies (breakup products and halo structure of light nuclei, molecular states).
- - Post-capture products and s, r, rp processes of astrophysical interest;
- - Gamma-ray spectroscopy and collective properties, super and hyper deformations.
- - Nuclear spectrometry and properties of exotic nuclei.
- **Evaluation method:** Continuous: 50% Exam: 50%
- **References :**
- Physiquenucléaire, BlancD, MassonParis1980.
  - Physique nucléaire et applications: Cours et exercices corrigés,ClaudeLeSech,ChristianNgô.Collection:SciencesSup,Dunod2010.
  - Luc Valentin, Noyaux et particules –Modèles et symétries, Hermann,1997.
  - A.de Shalit&H.Feshbach, Theoretical Nuclear Physics,2vol.,JohnWiley&Sons,1974.Volume1:Nuclear Structure; volume2:NuclearReactions.

- **Semester : 5**
- **UE : Methodology**
- **Subject : Digital Physics Credits : 4**
- **Coefficient : 2**
- **Objectives of the course:**
-
- The aim of this subject is to conceive and study methods for solving certain mathematical problems, generally resulting from the modeling of "real" problems, and whose solution is to be calculated with the help of a computer**.**
- **Recommended prior knowledge**
- Mathematics and computer science
- **Content of the subject :**
- **Chapter 1:** Polynomial interpolation of a function
- Polynomial interpolation of Lagrange, Newton by divided differences.
- Case of a regular division: progressive, regressive and central finite differences: formulas of Gregory-Newton, Gauss, Bessel, Everett
- **Chapter 2**: The best approximation
- Best continuous and discrete polynomial approximation in the least squares sense. Best trigonometric approximation of a periodic function.
- **Chapter 3**: Numerical solution of differential equations with initial conditions
- The Cauchy problem - Analytical methods of approximate solution (Taylor series - Picard method).
- Numerical methods for solving an equation of order one, a system of equations of the first order, an equation of order higher than one.
- Runge-Kutta methods
- Explicit and implicit multi-step methods
- - Prediction-correction method
- **Chapter 4**: Solving systems of linear equations.
- Direct methods (Gauss-Jordan methods, Choleski method for a symmetric and positive definite matrix, gradient method)
- - Iterative methods (Partitioning of the matrix of the system-Jacobi methods, relaxation methods) Conditioning of a matrix
- - Propagation of the error when solving a badly conditioned system.
-
- **Evaluation method:** Continuous: 50% Exam: 50%.
-
- **References:**
- Grégoire Allaire‘ Analyse numérique et optimisation ‘. Edition de l’Ecole Polytechnique(2007)

Semester : 5

UE : Methodology

Subject : Data Analysis Credits : 4

Coefficient : 2

Teaching objectives :

To give the students the techniques of numerical calculations with the application in machines.

Recommended prerequisite knowledge:

Numerical analysis and programming, and basic physics.

Content of the subject:

1. Formal calculation and simulation

- Introduction to symbolic computation software: Maple and/or Mathematica and/or Maxima

- Introduction to simulation software: Matlab and/or Octave.

- Dynamical systems and chaos

- Non-linear equations

- Numerical solution of ordinary and partial differential equations.

- Optimization. Monte Carlo methods.

- Applications to physical problems.

2. Statistical analysis of data

a) Experiments, data and statistics.

a. Experiments and data presentation.

b. Experimental errors.

b) Probability distributions.

a. Random variables.

b. Distributions (Normal, Exponential, Cauchy, bi-normal, Poisson, log-normal)

c) Sampling and estimation.

Evaluation method: Continuous: 50% Exam: 50%.

References:

- Grégoire Allaire‘ Analyse numérique et optimisation ‘. Edition de l’Ecole Polytechnique(2007)

- **Semester : 5**
- **UE : Discovery**
- **Subject : Particle Physics**
- **Credits : 1**
- **Coefficient : 1**
-
- **Teaching objectives:**
- **To learn the properties of elementary particles, their modes of interaction and decay.**
-
- **Recommended Prerequisites:**
- **Quantum mechanics, special relativity**
- **Content of the subject: I- Generalities**
- **The different types of particles, characteristic quantum numbers.**
- **CPT theorem.**
- **The different types of interactions and their conservation laws.**
-
- **II- Particle symmetries**
- **Parity and Parity of a particle-antiparticle system (case of bosons and fermions). Notion of quarks model.**
- **Flavor symmetry and notions of hadronic spectroscopy Color symmetry, gluons**
-
- **Evaluation method : Examination : 100%.**
-
- **References:** Robert Zitoun 'Introduction à la physique des particules'. Dunod(2004)
  - Benoit Clément' Physique des Particules' cours et exercices corrigés. Dunod (2013).

Semester : 5

UE : Discovery Subject : Acoustics Credits : 1

Coefficient : 1

Teaching objectives :

Treatment of noise pollution (noise reduction at the source, treatment of premises...)

Recommended prior knowledge :

acquired in S4

Content of the subject :

1- Reminders on Oscillations and resonance 2- Sound and sound sources

-Nature of sound phenomena

-Musical sounds

-Generation of waves, sources

-Ultrasonic waves

3- Properties of the Acoustic wave

-Acoustic pressure

-Cavitation

-Power and intensity

-The decibel -Geometric decay and absorption

-Interference

-Reflection and transmission

-Diffraction and scattering

4- Ultrasound and medical diagnosis

- The ultrasound beam -The attenuation coefficient

- Ultrasound -Doppler effect

- Measurement of blood flow velocity

- Bone densimetry

5- Sound waves in prospecting and industry

- Seismic prospecting

- Underwater detection

- Search for defects

- the acoustic microscope

- Sonochemistry

- Thermoacoustics

Evaluation method: 100% Exam

References :

- Antonio Fischetti 'Initiation à l'acoustique-Cours et exercices'.Belin(2003)
- André Brau ' Introduction à l'acoustique et à ses applications – Cours et exercices corrigés' Vuibert(2013).
- Antoine Chaigne 'Ondes acoustiques' Polytechnique(2002)

Semester : 5

UE : Discovery Subject : Biophysics Credits : 1

Coefficient : 1

Teaching objectives:

This course aims at providing the student with the knowledge to understand the laws, concepts, properties applicable to physical agents, and the elements of technological physics essential to medical imaging.

Recommended prerequisites: Content of the course:

Ionizing Radiation: X-ray Physics

1. **Reminders: electricity, electronics; structure of matter;**
2. **X-ray and electron beam production;**
3. **Radioactive transformations; electromagnetic pectrum;**
4. **Detection of ionizing radiation;**
5. **General properties of X-rays - gamma rays, scintigraphy, SPECT PET, concept of half-life.**
6. **Interactions with matter; environmental component;**
7. **Sensory biophysics: vision, hearing;**
8. **Circulation biophysics. Radioprotection and radiobiology**
9. **Dosimetric quantities and units, dose distribution in an Rx beam;**
10. **Radiobiology, risk factors,**
11. **Radioprotection; Radioprotection legislation.**

Evaluation method: 100% examination

References: (Books and handouts, websites, etc)

- **Semester : 5**
- **UE : Discovery**
- **Subject : Differential Geometry**
- **Credits : 1**
- **Coefficient : 1**
- **Teaching objectives:**
-
- Introduction to the notions of differential geometry which play a very important role in general relativity and gauge theories.
-
- **Recommended Pre requisites:**
- Vector calculus, Analysis
- **Content of the subject:**
- 1) Euclidean differential geometry
- - First quadratic form
- - Second quadratic form
- - Relations between the first and second quadratic forms
- - Geodesics
- - The example of two-dimensional surfaces of constant curvature
- - Translation of vectors and Levi-Civita theorem
- 2) Riemannian differential geometry - Tensors
- - Differentiable variables
- - Riemannian space
- - Curvature
- - Riemannian spaces of constant curvature
- - Differentiation and integration on varieties: introduction
- **Evaluation method :** exam
-
- **References:** Chilov:Analyse mathématique,éditionsMir,Moscou.

Semester : 5

UE : Discovery Subject : Energy Credits : 1

Coefficient : 1

Objectives of the course

The aim of this course is to provide a training on energies. The training aims at giving a panorama as broad as possible on the various forms of energies. It aims essentially to inform on the state of knowledge in the matter.

Content of the course :

Chapter 1: Generalities and basic concepts

Chapter 2: The different sources of energy

Chapter 3: The equivalences of energy units

Chapter 4: World energy production and consumption, reserves and forecasts

Chapter 5: Energy sources in Algeria

Mode of evaluation : Exam : 100%

- **Semester : 5**
- **UE : Discovery**
- **Subject : Didactic Processes**
- **Credits : 1**
- **Coefficient : 1**
- **Teaching objectives:**
- Special emphasis will be placed on the following five objectives:
- 1. To learn about teaching practices and the teaching profession.
- 2. Reflect on teaching practices and their context.
- 3. Design, plan and evaluate teaching and learning practices.
- 4. Work in a team and facilitate a group
- 5. Understand and analyze the school institution and its actors.
-
- **Recommended Prerequisites:**
- Basic knowledge of physics and different concepts and a command of the French language.
- **Content of the course:**
- 1- Introduction:
- - Definition, fields and objects
- - Didactics and human sciences, didactics and pedagogy, didactics and psychology, didactics and social psychology, didactics and epistemology.
- 2- Key concepts
- - The didactic triangle
- - The didactic transposition
- - The conceptions / representations of the students
- - The didactic obstacle and the objective-obstacle
- - The didactic contract
- - The didactic sequence / example of a problem situation
- 3- Missions of the teacher :
- 4- Teaching, explaining, convincing: how to help learners' conceptual changes? Tools and meansused.
- 5- Study of didactic situations.
- 6- Research methodology in didactics: documentary and bibliographic research
- 7- Preparation of a course and its presentation.
- **Evaluation method:**
- 01 final exam, continuous assessment, presentation and others.
-
- **References:**
- Aster. Didactique et histoire des sciences, éditions INRP,1986,n°5.
- VIENNOT,LRaisonneren physique, éditions De Boeck,1996.
- Aster, Revue de didactique des sciences expérimentales, INRP, N°5,1987,Didactique et histoire des sciences.
- ASTOLFI,J.P.et PETERFALVI,B. Obstacles et construction de situations didactiques en sciences expérimentales, inAster, éditionsINRP,1993,n°16,pp.100-110.

- RobardetG.(1995).Didactiquedessciencesphysiquesetformationdesmaîtres:contributionàl'analysed'un objet naissant. Thèse. Université Joseph Fourier, Grenoble.
- HARLENW.Enseigner les sciences, comment faire? Le Pommier,2004.
- DevelayM.,AstolfiJ.-P.,Ladidactiquedessciences,Paris,PUF,«Quesais-je7»,N°2448.

- **Semester : 5**
- **UE : Transversal**
- **Subject : Scientific English 1**
- **Credits : 1**
- **Coefficient : 1**
- **Teaching objectives**
- Improvement of general linguistic competence in terms of comprehension and expression, and acquisition of specialized vocabulary.
- **Recommended Prerequisites:**
- Notions of terminology, grammar, sentence construction and writing acquired in previous years.
- **Content of the course:**
- 1) Grammar review focusing on prepositions, definite and indefinite articles.
- 2) Texts will be proposed on : The kinetic theory of gases
- Relativity
- Waves and particles Optics
- Elements of statistical physics
- Each text will be given to the student, at least one week before the session, to allow him/her to prepare it without translating it.
- The teacher will make a presentation of the text during the session provided for this purpose, introducing the technical terms. The student will then be asked to explain the content and to summarize the text in written form using these terms.
- Finally, an exercise on the theme will be proposed, preferably an exercise already treated in the dedicated course.
- The objective is not to solve the exercise but to understand the content and to be able to formulate the solution in English.
-
- **Evaluation method :**
- Final exam, continuous assessment, presentation and others.
-
- **Bibliographical references :**
- Lire l'anglais scientifique et technique, Sally Bosworth, Bernard Marinier,1990.
- Comprendre l'anglais scientifique &technique, Sally Bosworth, Catherine Ingrand,Robert Marret,1992.

Semester : 6
UE : Fundamental
Subject : Solid State Physics Credits : 6
Coefficient : 3
Teaching objectives
Introduction to solid state physics. Study of the basic concepts of the solid state. Initiation to the main properties.
Recommended prior knowledge :
Basic knowledge of dynamics and solution of second order differential equations
Content of the course:
Chapter 1: CRYSTALLOGRAPHY
Crystal structure: pattern and lattice, mesh, crystal lattice, lattice planes and Miller indices, crystal symmetry, examples. Crystal diffraction: X-ray reflection (Bragg's law), diffraction by a crystal lattice, reciprocal lattice, structure factor, experimental methods. Crystal bonding: definition (crystal cohesion), neutral gas crystals, ionic crystals, covalent crystals, metallic crystals.
Chapter 2: MECHANICAL PROPERTIES - ELASTICITE
Definition, strain tensor, stress tensor, Hooke's law, isotropic body, crystalline body, elastic waves.
Chapter 3: VIBRATIONS AND THERMAL PROPERTIES OF NETWORK ATOMES
Vibrations of thecrystal lattice: one-dimensional chain of identical atoms, one-dimensional chain of different atoms, three-dimensional lattice, vibration modes, phonons. Thermal properties of the solid: classical theory, Einstein model, Debye model, thermal conductivity.
Chapter 4: ELECTRONS IN THE SOLID
Free electrons: Drude model, Fermi-Dirac model, 3D free electron gas, Cv of an electron gas, electrical conductivity (Ohm's law), motion in a magnetic field, Hall effect. Electrons in a periodic potential: almost free electron model, band theory, Bloch function, effective mass. Semiconductors: nature of charge carriers, intrinsic conductivity, extrinsic conductivity**.**
Chapter 5: DIELECTRICS
Electric fields, polarization, polarization mechanism, ferroelectricity, piezoelectricity, antiferroelectricity.

Chapter 6: MAGNETISM
Magnetic dipole moment, diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism**.**
Evaluation method : Continuous : 33% Exam : 67%.

References:-C.Kittel. Physique de l'étatsolide7eéd.DunodParis,1998
- C.Kittel. Physique de l'état solide : cours et problèmes, Dunod Paris,2002
- E.Mooser. Introduction à la physique des solides, Presses Polytechniques et universitaires romandes1993.
- B.Sapval. Physique des semi-conducteurs,,Ellipses Paris,1990.
- A.Saidani. Physique des semiconducteurs:T1, introduction à la structure cristalline, OPUAlger,1992.

Semester : 6
UE : Fundamental
Subject : Nuclear Physics
Credits : 4
Coefficient : 2
Objectives of the course

Introduction to the study of the nucleus
Recommended prerequisites
Atomic physics, Quantum mechanics I, Math3
Content of the subject :

Chapter 1: THE ATOMIC Nucleus
Structure of the nucleus
Nuclear binding energy
The liquid drop model

Chapter 2: NUCLEAR REACTIONS
General presentation
Energetics of nuclear reactions The model of the compound nucleus

Chapter 3: RADIOACTIVITY
The different types of radioactivity Decay laws
Some applications Dosimetry. Radioprotection

Chapter 4: NUCLEAR ENERGY
Nuclear fission Nuclear reactors Fusion

Evaluation method: Continuous: 33% Exam: 67%

References :

- Physique nucléaire, BlancD, Masso nParis1980.
- Physique nucléaire et applications: Cours et exercices corrigés, Claude LeSech, Christian Ngô. Collection: SciencesSup,Dunod2010.
- LucValentin ,Noyaux et particules –Modèles et symétries, Hermann,1997.
- A.deShalit&H.Feshbach, Theoretical Nuclear Physics,2vol.,JohnWiley&Sons,1974. Volume1:Nuclear Structure; volume2:NuclearReactions.

Semester : 6
UE : Fundamental
Subject : Heat Transfer
Credits : 4
Coefficient : 2
Objectives of the course
To allow students to master the different transport phenomena which are often linked and to acquire the fundamental notions for these phenomena. The objective of this subject is to present the phenomenon of heat transfer and to study in more detail the modes of transfer: conduction and convection**.**
Recommended prior knowledge:
Thermodynamics course, acquired in S4

Content of the course:
Chapter 1: General heat transfer: definitions, introduction, temperature field, heat flow, formulation of a heat transfer problem, heat balance, expression of energy flows.
Chapter 2: Conductive heat transfer, heat equation, steady state conduction, one-dimensional transfer, multidimensional transfer, one-dimensional variable conduction, uniform temperature medium, one-dimensional transfer in limited media plate, sphere, cylinder, fins, the bar equation, flux extracted by a fin, efficiency of a fin.
Chapter 3: Heat transfer by convection: dimensional analysis, advantage of using dimensional analysis, expression of heat fluxes by forced convection, expression of heat fluxes by free convection.
Chapter 4: Heat transfer by radiation: definitions, nature of radiation, radiation laws, calculation of exchanged fluxes.

Evaluation method: Continuous: 33% Exam: 67%.

References :

- A.Bouvenot, Transfert dechaleur,Paris,Masson1981

- B.Chéron, Transferts thermiques résumé de cours problémes corrigés,Paris,ellipses1999

Semester : 6
UE : Fundamental
Subject : Atomic Physics
Credits : 4
Coefficient : 2
Objectives of the course
Introduction to the study of the atom
Recommended prior knowledge
Quantum mechanics I, Physics3.

Content of the course :

Chapter 1: HYDROGEOID ATOMS (5h30h)
- Recall of the results of the Bohr-Sommerfeld model
- Quantum treatment of the hydrogen atom
- Eigenfunctions of stationary states
- Spatial distribution of the electron density
- Average values of space quantities Parity of a hydrogen state

Chapter 2: SEVERAL ELECTRON ATOMES (6h)
The layered model The alkaline atoms The helium atom

Chapter 3: RADIO TRANSITIONS (6h)
Transition probabilities Spectral line shapes Some applications

Chapter 4: X-rays Production and properties (4h30) Moseley's law
Auger effect

Evaluation method: Continuous: 33% Exam: 67%.
References:

- Physique atomique: tome1atomes et rayonnements interactions électromagnétiques, 2eéd., CagnacB, Dunod Paris2005.
- Physiqueatomique,tome2, applications de la mécanique quantique,CagnacB,Bordas,Paris1975.
- Problèmesdephysiqueatomique,Taleb.A,OPUAlger1988.
- Recueil d'exercices de physique atomique et moléculaire, Taleb.A, OPUAlger1989.

- **Semester : 6**
- **UE : Methodology**
- **Subject : Practical Work in Solid State Physics**
- **Credits : 4**
- **Coefficient : 2**
- **Objectives of the course**
-
- The aim of this course is to introduce some essential principles of condensed matter physics.
-
- **Recommended prerequisites:**
- Crystallography, solid state physics
- **Content of the course :**
-
- TP 1:Crystallography
-
- lab 2: Elasticity of an isotropic solid: torsion pendulum lab 3: Hall effect
- TP 4:Thermoelectronicemission
-
- lab 5: Electrical conduction in a semiconductor and current-voltage characteristic of a solar cell
-
-
- **Evaluation method:** Continuous: 50% Exam: 50%.
-
-
- **References :** C.Kittel. Physique de l'état solide7eéd.DunodParis,1998
  - C.Kittel. Physique de l'état solide :cours et problèmes, Dunod Paris,2002
  - E.Mooser. Introduction à la physique des solides, Presses Polytechniques et universitaires romandes1993.
  - B.Sapval. Physique des semi-conducteurs,,EllipsesParis,1990.
  - A.Saidani. Physique des semiconducteurs:T1, introduction à la structure cristalline,OPUAlger,1992.

Semester : 6

UE : Methodology

Subject : Practical Work in Physical Optics

Credits : 4

Coefficient : 2

Objectives of the course

The objective of this subject is the study of the wave character of light which explains certain phenomena while geometrical optics does not allow to answer them.

Recommended prerequisites:

Knowledge of basic mathematics. Knowledge of the Structure of Matter. Knowledge of the methods and tools of physics.

Content of the course :

TP 1: Study of the polarization of light

TP 2: Interferences: Young's holes, Fresnel mirrors and Fresnel biprism TP 3: Michelson interferometer

lab 4: Newton's rings

TP 5: Slit Diffraction TP 6: Diffraction Gratings

Evaluation method: Continuous: 50% Exam: 50%.

References :

- E.Vauthey. Petite introduction à la spectroscopie optique non-linéaire,2008 Département de Chimie-Physique de l'Université de Genève,30QuaiErnest Ansermet,CH-1211Genève4.
- P.W.Smith&W.J.Tomlinson, «Bistable optical devices promise subpico second switching »,inIEEESpectrum,vol.XVIII,p.26, 1981.
- T.F.Heinz,H.W.K.Tom&Y.R.Shen, «Nonlinear optical probes of interfaces»,inLaserFocus,vol.XIX,no5,p.101,Newtonville(Mass.),1983.
- N.Bloembergen. Nonlinear Optics, Addison-Wesley,Redding(Ma.),1991.

- **Semester : 6**
- **UE : Methodology**
- **Subject : Practical Work in Nuclear Physics**
- **Credits : 4**
- **Coefficient : 2**
- **Objectives of the course**
-
- The objective of this practical work is the practical illustration of some notions acquired in the Nuclear Physics subject.
-
- **Content of the subject :**
-
-
- TP 1: Study and efficiency of the Geiger Muller detector.
- Practical training 2:Nuclear statistics.
- TP 3: Attenuation of β and γ radiation in Al.
- TP 4: Attenuation of β and γ radiation in Pb.
-
- **Evaluation method : Continuous**: 50% Exam : 50%.
-
- **References :**

  - Physique nucléaire,BlancD,MassonParis1980.
  - Physique nucléaire et applications: Cours et exercices corrigés,ClaudeLeSech,ChristianNgô.Collection:SciencesSup,Dunod2010.
  - LucValentin, Noyaux et particules –Modèles et symétries, Hermann,1997.
  - A.deShalit&H.Feshbach, Theoretical Nuclear Physics,2vol.,JohnWiley&Sons,1974.Volume1:Nuclear Structure; volume2:Nuclear Reactions.

Semester : 6

UE : Methodology

Subject : Practical Work in Atomic Physics

Credits : 4

Coefficient : 2

Objectives of the course

The objective of this practical work is the practical illustration of some notions acquired in the subject Atomic Physics.

Content of the subject :

TP 1: Correlation between the power and the polarization of a He-Ne laser

lab 2: X-ray spectra and Bragg diffraction

lab 3: Electron spin resonance lab 4: Franck and Hertz experiment lab 5: Zeeman effect

TP 6: Measurement of the Rydberg constant

lab 7: Spectroscopy of two-electron atoms

Evaluation method : Continuous : 50% Examination : 50%

References :

- Physique atomique: tome1atomes et rayonnements interactions électromagnétiques, 2eéd.,CagnacB,Dunod Paris2005.
- Physique atomique, tome2, applications de la mécanique quantique,CagnacB,Bordas,Paris1975.
- Problèmes de physique atomique,Taleb.A,OPUAlger1988.
- Recueil d'exercices de physique atomique et moléculaire,Taleb.A, OPUAlger1989.

Semester : 6

EU : Discovery

Subject : Ethics and Deontology

Credits : 1

Coefficient : 1

Objectives of the course

Recommended prerequisite knowledge :

Electromagnetism, acquired in S4

Content of the subject:

Ancient ethics, modern ethics The minimalist perspective

Principle of sobriety Principle of stability Principle of neutrality Minimalism and pluralism

Evaluation method : Exam 100%

Semester : 6
UE : Discovery
Subject : Plasma Physics
Credits : 2
Coefficient : 2
Objectives of the course

The aim of this course is to introduce plasmas which constitute the fourth state of matter in the order of increasing temperature.

Recommended prior knowledge:

Electromagnetism, acquired in S4

Content of the course :

Chapter 1: The plasma medium: Definition and main characteristic quantities

Chapter 2: Individual motion of a charged particle in electric and magnetic fields

Chapter 3: Elementary processes in plasmas Chapter 4: Introduction to kinetic theory Chapter 5: Transport equations
Chapter 6: Introduction to the physics of dusty plasmas

Evaluation method : Examination : 100%.

References :

- F.F.CHEN. Introduction to plasma physics and controlled fusion,2éd.,vol.1,Plenum Press,1983.
- J.L.DELCROIXET A.BERS. Physique des plasmas, Savoirs actuels, vol.1, InterEditions/CNRSEditions,1994.
- J.F. DENISSEET J.L. DELCROIX.Théorie des ondes dans les plasmas, Dunod, 1961.
- B.HELD. Physique des plasmas froids, Masson,1994.
- Jean-MarcelRax. Physique des Plasmas, éditionDunod;Paris2005.
- Michel Moisan et JacquesPelletier. Physique des plasmas collisionnels,EDPsciences,2006.

Semester : 6

UE : Discovery Subject : Laser

Credits : 2

Coefficient : 2

Objectives of the course

The objective of this course is to provide students with a basic knowledge of the physical mechanisms involved in lasers. The various technologies currently used to produce certain types of lasers will be discussed.

Recommended prerequisites:

Content of the subject :

1- History.

2- Emission and Absorption of radiation - 2-level atomic system.

-Emission and absorption probabilities: Radiation balance

-Planck's radiative thermodynamic equilibrium and Einstein's relations.

-Population inversion.

-Population dynamics and population inversion. 3- Basic laser mechanisms

- Propagation of a light wave front in an active medium.

-Notion of absorption profile.

-Homogeneous and inhomogeneous broadening processes

-Oscillation and amplification. -Threshold condition.

-Disturbing phenomena.

4- Description of the main types of laser.

-Gas lasers: cw or implulsive.

-Solid state lasers with doped insulator.

-Semiconductor lasers.

-Liquid dye lasers.

X-ray laser -Free electron laser. 5- Various laser applications

-Applications in the scientific field.

-Medical applications

-Industrial applications

6- Safety classes of lasers

Evaluation method:100% examination

References : (Books and handouts, websites, etc)

- **Semester : 6**
- **UE : Discovery**
- **Subject : Solar Photovoltaic Cell**
- **Credits : 2**
- **Coefficient : 2**
- **Teaching objectives**
- - Can give examples of renewable energy sources.
- - Can describe examples of passive and active uses of solar energy.
- - Knows the orders of magnitude of efficiency and energy production**.**
- **Recommended Prerequisite Knowledge:**
- **Content of the subject:**
- -Solar radiation
- -Role of the Earth's atmosphere and ground radiation
- -Photo-electron
- -Photodiode
- -Photovoltaic modules
- -Photovoltaic systems
- -Characteristics of photodiodes
- -Optical Absorption
- -Short circuit current
- - circuit current
- -Siliconphotocells
- -Celltechnology
- -Very high efficiencycells
- -Photo-electrochemicalcells
-
- **Evaluation method :** 100% examination
- **References : (Books and handouts, websites, etc)**
- Production d'eau chaude solaire, Dimensionnement, montage, mise en service, entretien, PACER 724.213f,Office fédéral des questions conjoncturelles, Berne,1993.
  - Les installations solaires thermiques», PACER724.214f, Office fédéral des questions conjoncturelles, Berne,1993.

Semester : 6

UE : Discovery

Subject : New Materials

Credits : 2

Coefficient : 2

Objectives of the course

This subject deals with the physics and technology of metallic materials and their alloys, glasses, ceramics, polymers, composite materials and new materials and their applications.

Recommended prerequisite knowledge:

Basic knowledge of structure of matter; physical properties of solids; solid state physics.

Content of the course:

1- Reminder of the main properties of materials and their definitions. 2- Metals and metallic materials. Applications.

3- Alloys of the main metals: production and applications. 4- Heat treatments.

5- Glasses and special glasses: production and applications.

6- Ceramics and special ceramics: production and applications.

7- Polymers or plastics: different classes and applications. 8- Composite materials: obtaining different types and applications. 9- Nanomaterials: definition, properties and some applications.

10- Functional (or "intelligent") materials and their applications. 11- Superconducting materials: generalities and their applications.

Evaluation method :1 final exam

Bibliographical references :

[1]Y.Quéré: Physique des Matériaux(Ellipses1988).[2]Matériauxpolymères/H-H.Kausch,N.Heymans.

[3] Série d'articles de revues spécialisées d'actualité (Clefs CEA, Nature, CDER, Pour la recherche,La Recherche, Scienceet Vie,…).

- **Semester : 6**
- **UE : Discovery**
- **Subject : Nanotechnology**
- **Credits : 2**
- **Coefficient : 2**
- **Objectives of the course**
-
- The main concepts involved in the physics of structured systems at the nanometer scale are introduced: geometrical, electronic, optical, chemical, and transport aspects (in particular, spin transport), and several types of such systems are studied in detail: carbon nanotubes, systems for spintronics, aggregates, nanowires.
- **Recommended prior knowledge:**
- acquired in S4
-
- **Content of the course:**
-
- Chapter 1: Geometrical and electronic structure of aggregates and nanowires
- 1.1 Introduction (scaling laws and size effects, experimental aspects of aggregate physics, nano objects)
- 1.2 Electronic structure of nanostructures (Periodic systems and finite systems in one dimension; understanding the electronic structure of two and three dimensional nanosystems)
- 1.3. Aggregates (Rare gas aggregates: geometrical factors; metallic aggregates: electronic factors; semiconductor aggregates; ionic and molecular aggregates; quantum dots)
- 1.4. Semiconductor and metallic nanowires (Sensitivity of the conductance of semiconductor nanowires, monoatomic thickness wires)
- Chapter 2 : Carbon nanostructures
- 2.1 Synthesis and growth mechanisms of fullerenes, carbon nanotubes and graphene (Low temperature synthesis techniques, high temperature synthesis techniques, in situ diagnostics, nucleation and growth mechanisms using computer simulation approaches)
- 2.2 Structural properties (helicities, mono- and multilayer tubes, defects, bundles, junctions, tips ...) and experimental characterization (electron microscopy, diffraction, EELS, STM, resonant Raman, fluorescence, optical absorption ...)
- 2.3. Electronic and transport properties of fullerenes, carbon nanotubes and graphene (electronic structure, excitonic effects, 1D and 2D transport, spintronics, superconductivity, optoelectronics, field emission ...)
- 2.4. Mechanical and chemical properties of fullerenes, carbon nanotubes and graphene (nanoscale manipulation, composite materials, macroscopic assemblies, chemical doping, filling, functionalization, heterostructures...)
- 2.5. Thermal and optical properties of fullerenes, carbon nanotubes and graphene
- 2.6. Applications (Electronics - transistors, flat screens, electrodes...; electromechanics - actuators - NEMs, bio-chemical applications, nanosensors, energy storage,...)
- Chapter 3 : Spintronics
- 3.1 Spintronics (Concepts, effects and materials)
- 3.2 Giant magnetoresistance (Principle, CIP and CPP geometry, spin accumulation)
- 3.3. tunneling magnetoresistance (Principle, magnetic tunnel junctions)
-
- 3.4. Magneticnanowires (Fabrication methods, spin dependent magnetotransport)
- 3.5. New directions in spintronics (Spin transfer, spin electronics and semiconductors, molecular

spintronics, ...)

- Chapter 4 : Ethical and socio-economic aspects of nanotechnologies
-
- **Evaluation method :** Examination : 100%.
-
- **References:**

- EricDrexler. Engines of creation. Ed.Doubleday.USA.(1986).
- Nouailhat, Alain .Introduction aux nano sciences et aux nano technologies.
- Pierson,H.O.Handbook of Carbon, Graphite, Diamond and Fullerenes.William Andrew Publishing,Norwich(1993).

Semester : 6

UE : Discovery

Subject : Optoelectronics

Credits : 2

Coefficient : 2

Objectives of the course

Fundamental mechanisms of radiation emission or absorption by a semiconductor; exploitation of these mechanisms in optoelectronic devices.

Recommended prior knowledge

Quantum mechanics I.

Content of the subject :

Chapter 1: Optical properties of semiconductors

1.1 Dipolar elements in direct gap semiconductors

1.2 Optical Susceptibility of a Semiconductor

1.3. Absorption and spontaneous emission

1.4. Optical amplification conditions in semiconductors

Chapter 2: Semiconductor heterostructures and quantum wells

2.1. The envelope function formalism

2.2. Quantum wells

2.3. Density of states and statistics in a quantum well

2.4. Optical interband transitions in a quantum well

2.5. Optical inter-subband transitions in a quantum well

2.6. Optical absorption and angle of incidence

Chapter 3: Semiconductor Photodetectors

3.1. Carrier distribution in a photoexcited semiconductor

3.2. Photoconductors

3.3. Photovoltaic detector

3.4. Internal emission photodetector

3.5. Quantum well photodetector

3.6. Avalanche photodetector

Chapter 4: Light emitting diodes and laser diodes

4.1 Introduction

4.2 Electrical injection and non-equilibrium carrier densities

4.3. Light emitting diodes

4.4. Optical amplification in heterojunction diodes

4.5. Double heterojunction laser diodes

4.6. Quantum well laser diodes

4.7. Temporal behavior of laser diodes

4.8. Some characteristics of laser diode radiation

Evaluation method: Examination: 100%.

References:-H.Mathieu.Physique des semi-conducteurs et des composants électroniques: Cours 5eéd,Dunod Paris,2001.

- NgôChristian. Introduction à la physique des semi-conducteurs: cours et exercices corrigés, DunodParis,1998 .
- C.KITTEL. Introduction à la physique de l'état solide, Dunod (1972).
- W.A.Harrison, Electronic Structure and Properties of solids (Freeman, San Francisco,1980), (reprinte dby Dover,NewYork,1988).
- R.A.Smith.Semiconductors,2nd ed.Cambridge University Press.London 1979.
- A.Bousetta.Semi-conducteurs de la technologie aux dispositifs.
- F.T. S.Yu,“Fiber Optic Sensors”,Dekker,2002.
- B.Sapval. Physique des semi-conducteurs,EllipsesParis,1990.

- **Semester : 6**
- **UE : Transversal**
- **Subject : Scientific English 2 Credits : 1**
- **Coefficient : 1**
- **Teaching objectives :**
-
- Mastery of scientific English to understand and write scientific articles and present seminars in this language.
- **Recommended Prerequisites:**
- A minimum of English is prerequisite in addition to the subject Scientific English I.
- **Content of the subject:**
-
- This subject is part of the foreign language instruction for Physics majors. It is the second part of a series of two subjects spread over the 5th and 6th semester. At the end of the second semester of the third year of study, the student should be able to write and present adequately scientific texts related to the scientific specialties and in particular in Physics.
-
- **Evaluation method:**Examination: 100%.
-
- **References:**
- Readingtechnicalbooks,EINSENBERGA.,Ed.Prentice-Hall,Inc,1978.
- Sci-Tech,DrobnicF.,AbramsS.,MorrayM.,ELSPublications,1981.
- www.bbc.co.uk/learningenglish.

www.learnigenglish.org.uk/ki_frame.html.