الجمهورية الجزائرية الديمقراطية الشعبية
People's Democratic Republic of
Algeria وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education
and Scientific Research

University

Logo

TRAINING OFFER
L.M.D.

ACADEMIC LICENSE

NATIONAL PROGRAM
2021– 2022

Establishment	Faculty / Institute	Department

Field	Branch	Speciality
Sciences and Technologies	***Mechanical engineering***	***Energetics***

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People's Democratic Republic of Algeria
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research

اللجنة البيداغوجية الوطنية
لميدان العلوم و التكنولوجيا

National Pedagogical Committee for Science and Technology

عرض تكوين
ل. م . د
ليسانس أكاديمية

برنامج وطني
2021- 2022

المؤسسة	الكلية/ المعهد	القسم

الميدان	الفرع	التخصص
علوم و تكنولوجيا	هندسة ميكانيكية	طاقوية

I – Course organization sheets specialty

Semester 1

Teaching unit	Matter	Credit	Coefficient	Hourly weekly			Hourly Semester (1(**5 weeks**))	Complementary work (1(**5 weeks**))	Evaluation method	
	Entitled			**Class**	**Tutorial**	**PW**			**Continuous control**	**Exam**
Fundamental Unit Code : FU 1.1 Credits : 18 Coefficients : 9	Mathematics 1	6	3	3h00	1h30		67h30	82h30	40%	60%
	Physics 1	6	3	3h00	1h30		67h30	82h30	40%	60%
	Structure of Matter	6	3	3h00	1h30		67h30	82h30	40%	60%
Methodological unit Code : MU 1.1 Credits : 9 Coefficients : 5	Physics 1 (Lab)	2	1			1h30	22h30	27h30	100%	
	Chemistry 1 (Lab)	2	1			1h30	22h30	27h30	100%	
	Computer Science 1	4	2	1h30		1h30	45h00	55h00	40%	60%
	Writing Methodology	1	1	1h00			15h00	10h00		100%
Discovery unit Code : DU 1.1 Credits : 1 Coefficients : 1	Careers in Science and Technology 1	1	1	1h30			22h30	02h30		100%
Transversale Unit Code : TU 1.1 Credits : 2 Coefficients : 2	Ethical and Deontological Dimension (Foundations)	1	1	1h30			22h30	02h30		100%
	Language 1 (French and/or English)	1	1	1h30			22h30	02h30		100 %
Total semester 1		**30**	**17**	**16h00**	**4h30**	**4h30**	**375h00**	**375h00**		

Semester 2

Teaching unit	Matter	Credit	Coefficient	Hourly weekly			Hourly Semester (1**(5 weeks)**)	Complementary work (1**(5 weeks)**)	Evaluation method	
	Entitled			**Class**	**Tutorial**	**PW**			**Continuous control**	**Exam**
Fundamental Unit Code : FU 1.2 Credits : 18 Coefficients : 9	Mathematics 2	6	3	3h00	1h30		67h30	82h30	40%	60%
	Physics 2	6	3	3h00	1h30		67h30	82h30	40%	60%
	Thermodynamics	6	3	3h00	1h30		67h30	82h30	40%	60%
Methodological unit Code : MU 1.2 Credits : 9 Coefficients : 5	Physics 2 (Lab)	2	1			1h30	22h30	27h30	100%	
	Chemistry 2 (Lab)	2	1			1h30	22h30	27h30	100%	
	Computer Science 2	4	2	1h30		1h30	45h00	55h00	40%	60%
	Methodology of Presentation	1	1	1h00			15h00	10h00		100%
Discovery unit Code : DU 1.2 Credits : 1 Coefficients : 1	Careers in Science and Technology 2	1	1	1h30			22h30	02h30		100%
Transversale Unit Code : TU 1.2 Credits : 2 Coefficients : 2	Language 2 (French and/or English)	2	2	3h00			45h00	05h00		100 %
Total semestre 2		**30**	**17**	**16h00**	**4h30**	**4h30**	**375h00**	**375h00**		

Semester 3

Teaching unit	Matter	Credit	Coefficient	Hourly weekly			Hourly Semester (1**(5 weeks)**)	Complementary work (1**(5 weeks)**)	Evaluation method	
	Entitled			**Class**	**Tutorial**	**PW**			**Continuous control**	**Exam**
Fundamental Unit Code : FU 2.1.1 Credits : 10 Coefficients : 5	Mathematics 3	6	3	3h00	1h30		67h30	82h30	40%	60%
	Waves and Vibrations	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental Unit Code : FU 2.1.2 Credits : 8 Coefficients : 4	Fluid Mechanics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Rational Mechanics	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological unit Code : MU 2.1 Credits : 9 Coefficients : 5	Probability & Statistics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Computer Science 3	2	1			1h30	22h30	27h30	100%	
	Technical Drawing	2	1			1h30	22h30	27h30	100%	
	Waves and Vibrations (Lab)	1	1			1h00	15h00	10h00	100%	
Discovery unit Code : DU 2.1 Credits : 2 Coefficients : 2	Basic Technology	1	1	1h30			22h30	02h30		100%
	Metrology	1	1	1h30			22h30	02h30		100%
Transversale Unit Code : TU 2.1 Credits : 1 Coefficients : 1	Technical English	1	1	1h30			22h30	02h30		100%
Total semester 3		**30**	**17**	**13h30**	**7h30**	**4h00**	**375h00**	**375h00**		

Semester 4

Teaching unit	Matter	Credit	Coefficie	Hourly weekly			Hourly Semester (1**(5 weeks)**)	Complementary work (1**(5 weeks)**)	Evaluation method	
	Entitled			**Class**	**Tutorial**	**PW**			**Continuous control**	**Exam**
Fundamental Unit Code : FU 2.2.1 Credits : 6 Coefficients : 3	Thermodynamics 2	4	2	1h30	1h30		45h00	55h00	40%	60%
	Mechanical Manufacturing	2	1	1h30			22h30	27h30		100%
Fundamental Unit Code : FU 2.2.2 Credits : 8 Coefficients : 4	Mathematics 4	4	2	1h30	1h30		45h00	55h00	40%	60%
	Numerical methods	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental Unit Code : FU 2.2.3 Credits : 4 Coefficients : 2	Strength of Materials	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological unit Code : MU 2.2 Credits : 9 Coefficients : 5	Computer-Aided Design	2	1			1h30	22h30	27h30	100%	
	Fluid Mechanics (Lab)	2	1			1h30	22h30	27h30	100%	
	Numerical Methods (Lab)	2	1			1h30	22h30	27h30	100%	
	Material Resistance (Lab)	1	1			1h00	15h00	10h00	100%	
	Mechanical Manufacturing (Lab)	2	1			1h30	22h30	27h30	100%	
Discovery unit Code : DU 2.2 Crédits : 2 Coefficients : 2	Industrial electricity	1	1	1h30			22h30	02h30		100%
	Materials Science	1	1	1h30			22h30	02h30		100%
Transversale Unit Code : TU 2.2 Credits : 1 Coefficients : 1	Techniques of Expression, Information, and Communication	1	1	1h30			22h30	02h30		100%
Total semestre 4		**30**	**17**	**12h00**	**6h00**	**7h00**	**375h00**	**375h00**		

Semester 5

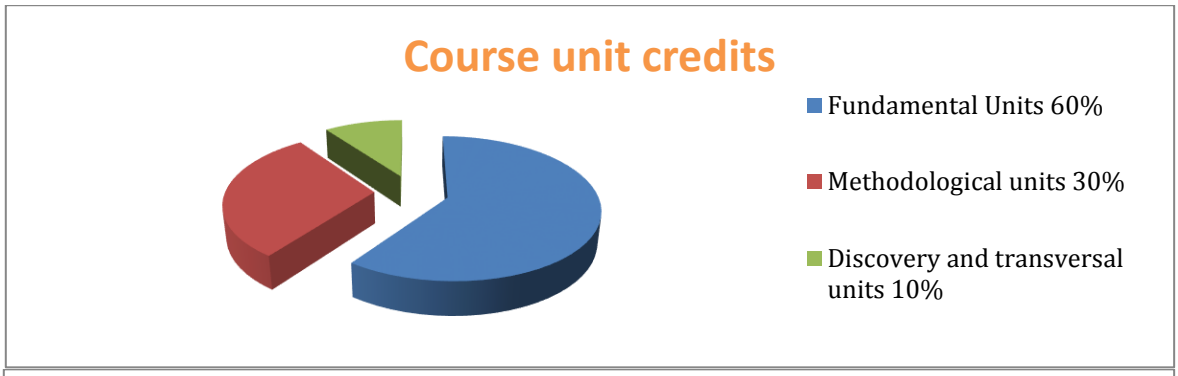
Teaching unit	Matter	Credit	Coefficient	Hourly weekly			Hourly Semester (1(**5 weeks**))	Complementary work (1(**5 weeks**))	Evaluation method	
	Entitled			**Class**	**Tutorial**	**PW**			**Continuous control**	**Exam**
Fundamental Unit Code : FU 3.1.1 Credits : 10 Coefficients : 5	Fluid Mechanics 2	6	3	3h00	1h30		67h30	82h30	40%	60%
	Heat Transfer 1	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental Unit Code : FU 3.1.2 Credits : 8 Coefficients : 4	Turbomachinery 1	4	2	1h30	1h30		45h00	55h00	40%	60%
	Energy Conversion	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological unit Code : MU 3.1 Credits : 9 Coefficients : 5	Heat Transfer (Lab)	2	1			1h30	22h30	27h30	100%	
	Turbomachines 1 (Lab)	2	1			1h30	22h30	27h30	100%	
	Energy Conversion (Lab)	2	1			1h30	22h30	27h30	100%	
	Measurement and instrumentation	3	2	1h30		1h00	37h30	37h30	40%	60%
Discovery unit Code : DU 3.1 Credits : 2 Coefficients : 2	Introduction to machine elements	1	1	1h30			22h30	02h30		100%
	Control and Servomechanisms	1	1	1h30			22h30	02h30		100%
Transversale Unit Code : TU 3.1 Credits : 1 Coefficients : 1	Environment and Sustainable Development	1	1	1h30			22h30	02h30		100%
Total semester 5		**30**	**17**	**13h30**	**6h00**	**5h30**	**375h00**	**375h00**		

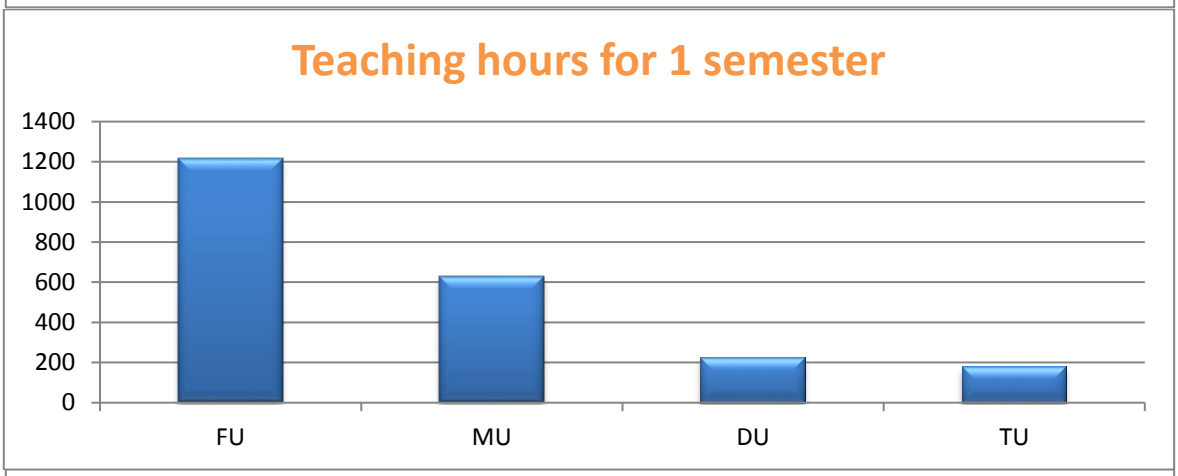
Semester 6

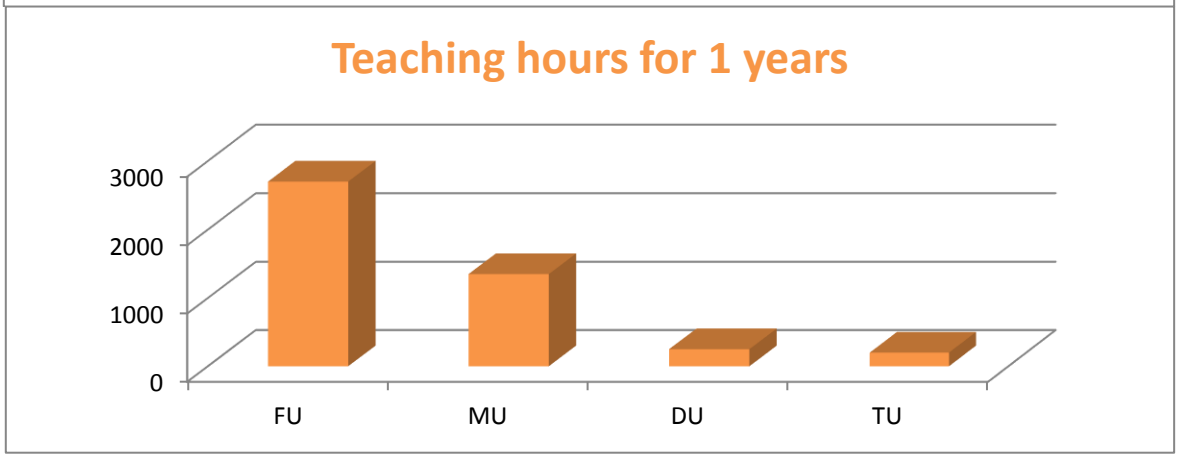
Teaching unit	Matter	Credit	Coefficient	Hourly weekly			Hourly Semester (1(**5 weeks**))	Complementary work (1(**5 weeks**))	Evaluation method	
	Entitled			**Class**	**Tutorial**	**PW**			**Continuous control**	**Exam**
Fundamental Unit Code : FU 3.2.1 Credits : 10 Coefficients : 5	Turbomachinery 2	6	3	3h00	1h30		67h30	82h30	40%	100%
	Internal Combustion Engines	4	2	1h30	1h30		45h00	55h00	40%	100%
Fundamental Unit Code : FU 3.2.2 Credits : 8 Coefficients : 4	Refrigeration Machines and Heat Pumps	4	2	1h30	1h30		45h00	55h00	40%	100%
	Heat Transfer 2	4	2	1h30	1h30		45h00	55h00	40%	100%
Methodological unit Code : MU 3.2 Credits : 9 Coefficients : 5	Final project	4	2			3h00	45h00	55h00	100%	
	Refrigeration and Heat Pump (Lab)	2	1			1h30	22h30	27h30	100%	
	Internal Combustion Engines (Lab)	1	1			1h00	15h00	10h00	100%	
	Control and Servo Control (Lab)	2	1			1h30	22h30	27h30	100%	
Discovery unit Code : DU 3.2 Credits : 2 Coefficients : 2	Renewable Energies	1	1	1h30			22h30	02h30		100%
	Cryogenics	1	1	1h30			22h30	02h30		100%
Transversale Unit Code : TU 3.2 Credits : 1 Coefficients : 1	Entrepreneurship and Business Management	1	1	1h30			22h30	02h30	100%	
Total semestre 6		**30**	**17**	**12h00**	**6h00**	**7h00**	**375h00**	**375h00**		

Overall summary of the training:

Units / TH	FU	MU	DU	TU	Total
Class	720h00	120h00	225h00	180h00	1245h00
Tutorial	495h00	22h30	---	---	517h30
PW	---	487h30	---	---	487h30
Personal work	1485h00	720h00	25h00	20h00	2250h00
other	---	---	---	---	---
Total	2700h00	1350h00	250h00	200h00	4500h00
Credits	108	54	10	8	180
% in credits for each teaching unit	60 %	30 %	10 %		100 %







II - Detailed program by subject

Semester: 1
Teaching unit: FU 1.1
Subject 1: Mathematics 1
TH/S: 67h30 (Class: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives::
This first mathematics subject is mainly devoted to homogenizing the level of students entering university. The first new elements are taught progressively in order to lead students towards more advanced mathematics. The concepts covered in this subject are fundamental and among the most commonly used in the field of Science and Technology.

Recommended prerequisites::
Basic knowledge of mathematics from terminal classes (sets, functions, equations, etc.).

Content of the subject::

Chapter 1. Methods of mathematical reasoning (**(1 week)**)
1-1 Direct reasoning. 1-2 Reasoning by contraposition. 1-3 Reasoning by absurdity. 1-4 Reasoning by counterexample. 1-5 Reasoning by recurrence.

Chapter 2. Sets, relations and mappings **((2 weeks))**
2-1 Set theory. 2-2 Order relations, equivalence relations. 2-3 Injective, surjective, bijective mapping: definition of a mapping, direct image, reciprocal image, characteristics of a mapping.

Chapter 3. Real functions of a real variable **((3 weeks))**
3-1 Limit, continuity of a function. 3-2 Derivative and differentiability of a function.

Chapter 4. Application to elementary functions **((3 weeks))**
4-1 Power function. 4-2 Logarithmic function. 4-3 Exponential function. 4-4 Hyperbolic function. 4-5 Trigonometric function. 4-6 Inverse function.

Chapter 5. Limit expansion **((2 weeks))**
5-1 Taylor's formula. 5-2 Limit expansion. 5-3 Applications.

Chapter 6. Linear Algebra **((4 weeks))**
6-1 Laws and internal composition. 6-2 Vector space, base, dimension (definitions and elementary properties). 6-3 Linear mapping, kernel, image, rank.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical references:
1- K. Al(Lab), Eléments d'analyse, Fonction d'une variable réelle, 1re & 2e années d'université, Office des Publications universitaires.
2- J. Rivaud, Algèbre : Classes préparatoires et Université Tome 1, Exercices avec solutions, Vuibert.
3- N. Faddeev, I. Sominski, Recueil d'exercices d'algèbre supérieure, Edition de Moscou
4- M. Ba(Lab)ne, M. Duflo, M. Frish, D. Guegan, Géométrie – 2e année du 1er cycle classes préparatoires, Vuibert Université.
5- B. Calvo, J. Doyen, A. Calvo, F. Boshet, Exercices d'algèbre, 1er cycle scientifique préparation aux grandes écoles 2e année, Armand Colin – Collection U.

6- J. Quinet, Cours élémentaire de mathématiques supérieures 1- Algèbre, Dunod.
7- J. Quinet, Cours élémentaire de mathématiques supérieures 2- Fonctions usuelles, Dunod.
8- J. Quinet, Cours élémentaire de mathématiques supérieures 3- Calcul intégral et séries, Dunod.
9- J. Quinet, Cours élémentaire de mathématiques supérieures 4- Equations différentielles, Dunod.

Semester: 1
Teaching unit: FU 1.1
Subject 2: Physics 1
TH/S: 67h30 (Class: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
Introduce the student to the basics of Newtonian physics through three main parts: Kinematics, Dynamics, and Work and Energy.

Recommended prerequisites:
Some knowledge of mathematics and physics.

Content of the subject::

Mathematical reminders **((2 weeks))**
1- Equations with dimensions
2- Vector calculus: scalar product (norm), vector product, functions with several variables, derivation. Vector analysis: gradient operators, curl, etc.

Chapter 1. Kinematics **((5 weeks))**
1- Position vector in coordinate systems (Cartesian, cylindrical, spherical, curvilinear) - Motion law - Trajectory. 2- Velocity and acceleration in coordinate systems. 3- Applications: Motion of a material point in different coordinate systems. 4- Relative motion.

Chapter 2. Dynamics **((4 weeks))**
1- Generalities: Mass - Force - Moment of force - Absolute and Galilean reference frame. 2- Newton's laws. 3- Conservation of momentum. 4- Differential equation of motion. 5- Angular momentum. 6- Applications of the fundamental law for forces (constant, time-dependent, velocity-dependent, central force, etc.).

Chapter 3. Work and Energy **((4 weeks))**
1- Work of a force. 2- Kinetic energy. 3- Potential energy - Examples of potential energy (gravity, gravitational, elastic). 4- Conservative and non-conservative forces - Total energy theorem.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references::
1. A. Gibaud, M. Henry ; Cours de physique - Mécanique du point - Cours et exercices corrigés; Dunod, 2007.
2. P. Fishbane et al. ; Physics For Scientists and Engineers with Modern Physics, 3rd Ed. ; 2005.
3. P. A. Tipler, G. Mosca ; Physics For Scientists and Engineers, 6th Ed., W. H. Freeman Company, 2008.

Semester: 1
Teaching Unit: FU 1.1
Subject 3: Structure of Matter
TH/S: 67h30 (Class: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
This subject provides students with the basic formalisms of chemistry, particularly within matter describing atoms and chemical bonding, chemical elements and the periodic table with energy quantification. It makes students more able to solve chemistry problems.

Recommended prerequisites:
Basic knowledge of mathematics and general chemistry.

Content of the subject::

Chapter 1. Fundamental Concepts **((2 weeks))**
States and macroscopic characteristics of matter states, changes in matter states, atom, molecule, mole and Avogadro's number, atomic mass unit, atomic and molecular molar mass, molar volume, Law of mass conservation (Lavoisier), chemical reaction, Qualitative aspect of matter, Quantitative aspect of matter.

Chapter 2. Main Components of Matter **((3 weeks))**
Introduction: Faraday's experiment: relationship between matter and electricity, identification of the components of matter, therefore the atom and some physical properties (mass and charge), Rutherford's planetary model, Presentation and characteristics of the atom (symbol, atomic number Z, mass number A, number of protons, neutrons, and electrons), isotopes, and relative abundance of different isotopes, separation of isotopes, and determination of atomic mass and average mass of an atom: mass spectrometry: Bainbridge spectrograph, Binding energy and cohesion of nuclei, Stability of nuclei.

Chapter 3. Radioactivity - Nuclear Reactions **((2 weeks))**
Natural radioactivity (α, β, and γ radiation), Artificial radioactivity and nuclear reactions, Kinetics of radioactive decay, Applications of radioactivity.

Chapter 4. Electronic Structure of the Atom **((2 weeks))**
Wave-particle duality, Interaction between light and matter, Bohr's atomic model: hydrogen atom, Hydrogen atom in wave mechanics, Poly-electronic atoms in wave mechanics.

Chapter 5. Periodic Classification of Elements **((3 weeks))**
Mendeleev's periodic classification, Modern periodic classification, Evolution and periodicity of physicochemical properties of elements, Calculation of radii (atomic and ionic), successive ionization energies, electron affinity, and electronegativity (Mulliken scale) using Slater's rules.

Chapter 6. Chemical Bonding **((3 weeks))**
Covalent bonding in Lewis theory, Polarized covalent bonding, dipole moment and partial ionic character of bonding, Geometry of molecules: Gillespie or VSEPR theory, Chemical bonding in quantum mechanics.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:
1. Ouahes, Devallez, Chimie Générale, OPU.
2. S.S. Zumdhal & coll., Chimie Générale, De Boeck Université.
3. Y. Jean, Structure électronique des molécules : 1 de l'atome aux molécules simples, 3e édition, Dunod, 2003.
4. F. Vassaux, La chimie en IUT et BTS.
5. A. Casalot & A. Durupthy, Chimie inorganique cours 2ème cycle, Hachette.
6. P. Arnaud, Cours de Chimie Physique, Ed. Dunod.
7. M. Guymont, Structure de la matière, Belin Coll., 2003.
8. G. Devore, Chimie générale : T1, étude des structures, Coll. Vuibert, 1980.
9. M. Karapetiantz, Constitution de la matière, Ed. Mir, 1980.

Semester: 1
Teaching unit: MU 1.1
Subject 1: Physics 1 (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Consolidate the theoretical knowledge acquired in class through practical manipulations.

Recommended prerequisites:
Basic knowledge of mathematics and physics.

Content of the subject::
At least 5 experiments (3h00 / 15 days):

Methodology for presenting (Lab) reports and error calculations.
Verification of the 2nd law of Newton.
Free fall.
Simple pendulum.
Elastic collisions.
Inelastic collisions.
Moment of inertia.
Centrifugal force.

Assessment method:
Continuous control: 100%.

Semester: 1
Teaching unit: MU 1.1
Subject 2: Chemistry 1 (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
Consolidate theoretical knowledge provided in the structure of matter course through practical experiments.

Recommended prerequisites:
Basic chemistry concepts.

Content of the subject::

(Lab)oratory safety
Preparation of solutions
Concepts of uncertainty calculations applied to chemistry.
Acid-base titration by colorimetry and pH-metry.
Acid-base titration by conductometry.
Redox titration
Determination of water hardness
Determination of ions in water: chloride ions by the Mohr method.

Assessment method:
Continuous control: 100%.

Semester: 1
Teaching Unit: MU 1.1
Subject 3: Computer Science 1
TH/S: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Objective and recommendations:
The objective of this subject is to enable students to learn how to program using an advanced language (Fortran, Pascal or C). The choice of language is left to the discretion of each institution. The notion of algorithm should be implicitly taken care of during the learning of the language.

Recommended prerequisites::
Basic knowledge of Web technology.

Content of the subject::
Part 1. Introduction to Computer Science **((5 weeks))**
1- Definition of computer science
2- Evolution of computer science and computers
3- Information coding systems
4- Principle of computer operation
5- Computer hardware
6- System part
Basic systems (operating systems (Windows, Linux, Mac OS, ...)
Programming languages, application software

Part 2. Notions of Algorithm and Program (10 Weeks)
1- Concept of an algorithm
2- Representation in flowcharts
3- Program structure
4- Approach and analysis of a problem
5- Data structure: Constants and variables, Data types
6- Operators: Assignment operator, Relational operators, Logical operators, Arithmetic operations, Priorities in operations
7- Input/ouPWut operations
8- Control structures: Conditional control structures, Repetitive control structures

Computer Science 1 Tutorials:
The tutorials aim to illustrate the concepts taught during the lectures. They must start with the lectures according to the following schedule:
• Introduction and familiarization tutorial with the computer machine from a hardware and operating system point of view (exploration of the different OS functionalities)
• Introduction tutorial to the use of a programming environment (Editing, Assembling, Compilation, etc.)
• Application tutorial of programming techniques seen in class.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references::

1- John Paul Mueller et Luca Massaron, Les algorithmes pour les Nuls grand format, 2017.
2- Charles E. Leiserson, Clifford Stein et Thomas H. Cormen, Algorithmique: cours avec 957 exercices et 158 problèmes, 2017.
3- Thomas H. Cormen, Algorithmes: Notions de base, 2013.

Semester: 1
Teaching Unit: MU 1.1
Subject 4: Writing Methodology
TH/S: 15h00 (Course: 1h00)
Credits: 1
Coefficient: 1

Teaching objectives:
To familiarize and train students with the current concepts of writing methodology in the field of Science and Technology. Among the skills to be acquired: Knowing how to introduce oneself; Knowing how to write a resume and a cover letter; Knowing how to express oneself in writing or orally in relation to an opinion or an idea; Mastering syntax and spelling in writing.

Recommended prerequisites:
Basic French. Basic principles of writing a document.

Content of the subject::
Chapter 1. Concepts and generalities on writing techniques **((2 weeks))**

Definitions, standards
Applications: writing a summary, a letter, a request
Chapter 2. Information search, synthesis and exploitation **((3 weeks))**

Information search in the library (Paper format: Books, Journals)
Information search on the Internet (Digital: Databases; Search engines, etc.)
Applications
Chapter 3. Writing techniques and procedures **((3 weeks))**

Basic principles of writing - Punctuation, Syntax, Sentences
Sentence length
Paragraph division
Use of a neutral style and third-person writing
Readability
Objectivity
Intellectual rigor and Plagiarism
Chapter 4. Writing a Report **((4 weeks))**
Cover pages, Table of contents, Introduction, Method, Results, Discussion, Conclusion, Bibliography, Annexes, Summary and Keywords

Chapter 5. Applications **((3 weeks))**
Report of a practical work

Assessment method:
Exam: 100%.

Bibliographical Bibliographical references::
1. J.-L. Lebrun, Guide pratique de rédaction scientifique, EDP Sciences, 2007.
2. M. Fayet, Réussir ses comptes rendus, 3e édition, Eyrolles, 2009.
3. M. Kalika, Mémoire de master - Piloter un mémoire, Rédiger un rapport, Préparer une soutenance, Dunod, 2016.
4. M. Greuter, Réussir son mémoire et son rapport de stage, l'Etudiant, 2014

5. F. Cartier, Communication écrite et orale, Edition GEP- Groupe Eyrolles, 2012.
6. M. Fayet, Méthodes de communication écrite et orale, 3e édition, Dunod, 2008.
7. E. Riondet, P. Lenormand, Le grand livre des modèles de lettres, Eyrolles, 2012.
8. R. Barrass, Scientist must write – A guide to better writing for scientists, engineers and students, 2d edition, Routledge, 2002.
9. G. Andreani, La pratique de la correspondance, Hachette, 1995.
10. Ph. Rubens, Science & Technical Writing, A Manual of Style, 2d edition, Routledge, 2001.
11. A. Wallwork, User Guides, Manuals, and Technical Writing – A Guide to Professionnal English, Springer, 2014.

Semester: 1
Teaching Unit: TU 1.1
Subject 1: Careers in Science and Technology 1
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
To introduce the student, in the first stage, to all the fields covered by the Science and Technology domain, and in the second stage, to a range of careers avai(Lab)le in these fields. In the same context, this subject introduces new sustainable development issues and the new careers that can arise from them.

Recommended prerequisites:
None.

Content of the subject::

What are engineering sciences? **((2 weeks))**
The engineering profession, historical context, and challenges of the 21st century, searching for a job/recruitment advertisement by keyword, creating a simple job description (job title, company, main activities, required skills (knowledge, know-how, interpersonal skills).

Fields of Electronics, Telecommunications, Biomedical Engineering, Electrotechnology, Electromechanics, Optics & Precision Mechanics: **((2 weeks))**

Definitions, application areas (home automation, embedded applications for cars, video surveillance, mobile phones, fiber optics, cutting-edge scientific instrumentation, medical imaging and instrumentation, giant mirrors, contact lenses, electric power transport and distribution, power plants, energy efficiency, industrial equipment maintenance, elevators, wind turbines, etc.)
The role of specialists in these fields.
Fields of Automation and Industrial Engineering: (**(1 week)**)
Definitions, application areas (industrial automated chains, numerical control machine tools, robotics, inventory management, goods traffic management, quality control)
The role of specialists in these fields.
Fields of Process Engineering, Hydrocarbons and Petrochemical Industries: **((2 weeks))**
Definitions, Pharmaceutical industry, Agri-food industry, Leather and textile industry, Biotechnologies, Chemical and petrochemical industry, Plastics industry, Energy sector (oil, gas), etc.
The role of specialists in these fields.
Sustainable Development (SD): **((4 weeks))**
Definitions, global issues (climate change, demographic transitions, depletion of resources (oil, gas, coal, etc.), impoverishment of biodiversity, etc.), SD diagram (Sustainable = Viable + Livable + Fair), SD stakeholders (governments, citizens, socio-economic sector, international organizations, etc.), the global nature of SD challenges.

Sustainable Engineering: **((4 weeks))**
Definition, principles of sustainable engineering (definitions of: sustainable/energy efficiency, sustainable mobility/eco-mobility, resource recovery (water, metals, and minerals, etc.), sustainable production), relevance of sustainable engineering in ST fields, relationship between sustainability and engineering, engineers' responsibility in achieving sustainable projects, etc.

Student's Personal Work for this Subject:

The teacher in charge of this subject can let the students know that they can always be assessed by asking them to prepare job description sheets. They can ask the students to watch a popular science film related to the chosen profession at home (after providing them with either the film on electronic support or the internet link to the film) and then ask them to submit a written report or make an oral presentation of the summary of this film, etc. The evaluation of these activities is left to the discretion of the teacher and the training team, who are the only ones capable of defining the best way to take these personal works into account in the overall grade of the final exam.

Group Work: Development of job descriptions for each sector based on recruitment ads found on employment demand websites (e.g. htPW://www.onisep.fr/Decouvrir-les-metiers, www.indeed.fr, www.pole-emploi.fr) (1 sector/group). Depending on the institution's capabilities, recommend using doctoral students and alumni from the institution in a mentoring/tutoring program where each group can call on its tutor/mentor to develop the job description/discover different ST careers.

Assessment method:

100% exam

Bibliographical Bibliographical references:::

1- Quels métiers pour demain ? Éditeur : ONISEP, 2016, Collection : Les Dossiers.
2- J. Douënel et I. Sédès, Choisir un métier selon son profil, Editions d'Organisation, Collection : Emploi & carrière, 2010.
3- V. Bertereau et E. Ratière, Pour quel métier êtes-vous fait ? Editeur : L'Étudiant, 6e édition, Collection : Métiers, 2015.
4- Le grand livre des métiers, Éditeur : L'Étudiant, Collection : Métiers, 2017.
5- Les métiers de l'industrie aéronautique et spatiale, Collection : Parcours, Edition : ONISEP, 2017.
6- Les métiers de l'électronique et de la robotique, Collection : Parcours, Edition : ONISEP, 2015.
7- Les métiers de l'environnement et du développement durable, Collection : Parcours, Edition : ONISEP, 2015.
8- Les métiers du bâtiment et des travaux publics, Collection : Parcours, Edition : ONISEP, 2016.
9- Les métiers du transport et de la logistique, Collection : Parcours, Edition : ONISEP, 2016.
10- Les métiers de l'énergie, Collection : Parcours, Edition : ONISEP, 2016.
11- Les métiers de la mécanique, Collection : Parcours, Edition : ONISEP, 2014.
12- Les métiers de la chimie, Collection : Parcours, Edition : ONISEP, 2017.
13- Les métiers du Web, Collection : Parcours, Edition : ONISEP, 2015.
14- Les métiers de la biologie, Collection : Parcours, Edition : ONISEP, 2016.

Semester: 1
Teaching unit: TU 3.1
Subject: Ethical and Deontological Dimension (Foundations)
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::

The main objective of this course is to facilitate an individual's immersion into student life and their transition into a responsible adult. It aims to develop students' awareness of ethical principles and to initiate them into the rules that govern life at university (their rights and obligations vis-à-vis the university community) and in the world of work. The course also aims to sensitize students to the respect and valorization of intellectual property and to explain the risks of moral evils such as corruption and how to combat them.

Recommended prerequisites:

None

Content of the subject::

I. Fundamental Notions - مفاهم أساسية **((2 weeks))**
Definitions:

Morality:
Ethics:
Deontology "Theory of Duty":
Law:
Distinction between different notions
A. Distinction between ethics and morality
B. Distinction between ethics and deontology
II. References - المرجعيات **((2 weeks))**
Philosophical references
Religious reference
The evolution of civilizations
Institutional reference
III. University Franchises - الحرم الجامعي **((3 weeks))**
The concept of university franchises
Regulatory texts
University franchise fees
Actors of the university campus
IV. University Values - القيم الجامعية **((2 weeks))**
Social values
Community values
Professional values
V. Rights and Duties **((2 weeks))**
The rights of the student
The duties of the student
Rights of teachers
Obligations of teacher-researchers

Obligations of administrative and technical staff
VI. University Relations **((2 weeks))**
Definition of the concept of university relations
Student-teacher relationships
Student-student relationships
Student-staff relationships
Student-Association members relationships
VII. Practices **((2 weeks))**
Good practices for teachers
Good practices for students

Bibliographical Bibliographical references:

1. Recueil des cours d'éthique et déontologie des universités algériennes.
2. BARBERI (J.-F.), 'Morale et droit des sociétés', *Les Petites Affiches,* n° 68, 7 juin 1995.
3. J. Russ, *La pensée éthique contemporaine*, Paris, puf, *Que sais-je ?,* 1995.
4. LEGAULT, G. A., Professionnalisme et délibération éthique, Québec, Presses de l'Université du Québec, 2003.
5. SIROUX, D., 'Déontologie', dans M. Canto-Sperber (dir.), Dictionnaire d'éthique et de philosophie morale, Paris, Quadrige, 2004.
6. Prairat, E. (2009). Les métiers de l'enseignement à l'heure de la déontologie. *Education et Sociétés, 23*.
7. htPWs://elearning.univ-annaba.dz/pluginfile.php/39773/mod_resource/content/1/Cours%20Ethique%20et%20la%20d%C3%A9ontologie.pdf .

Semester: 1
Teaching Unit: TU 1.1
Course: French Language 1
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::
The main objective of this course is to develop the four language skills: oral comprehension, written comprehension, oral expression, and written expression through the reading and study of texts.

Recommended prerequisites:
Basic French.

Content of the subject::
Below is a list of topics that address fundamental sciences, technologies, economy, social issues, communication, sports, health, etc. The teacher can choose texts from this list to develop during the class. Otherwise, they are free to address other topics of their choice. Texts can be taken from various communication media: newspapers, sports or entertainment magazines, specialized or popular science magazines, books, websites, audio and video recordings, etc.
For each text, the teacher helps the student to develop their language skills: listening, comprehension, oral and written expression. In addition, the teacher should use the text to identify grammatical structures that they will develop during the same class session. Here are some example grammatical structures that can be developed, but it is not necessary to cover them all or in the same way. Some structures can be briefly reviewed while others can be detailed.

Examples of topics.	Grammatical structures
Climate change Pollution Electric car Robots Artificial intelligence Nobel Prize Olympic games Sports at school The Sahara Currency Assembly line work Ecology Nanotechnology Fiber optic Engineering profession Power plant Energy efficiency Smart building Wind energy Solar energy	Punctuation. Proper nouns, Articles. Grammatical functions: Noun, Verb, Pronoun, Adjective, Adverb. The complement pronoun 'le, la, les, lui, leur, y, en, me, te, ...' Agreements. Negative sentence. Ne ... pas, Ne ... pas encore, Ne ... plus, Ne ... jamais, Ne ... point, ... Interrogative sentence. Question with 'Qui, Que, Quoi', Question with 'Quand, Où, Combien, Pourquoi, Comment, Quel, Lequel'. Exclamatory sentence. Reflexive verbs. Impersonal verbs. Tenses of the indicative: Present, Future, Past perfect, Simple past, Imperfect.

Assessment method:
100% exam

Bibliographical Bibliographical references:

1. M. Badefort, Objectif : Test de Français International, Edulang, 2006.
2. O. Bertrand, I. Schaffner, Réussir le TCF, Exercices et activités d'entrainement, Les éditions de l'école polytechnique, 2009.
3. M. Boulares, J.-L. Frerot, Grammaire progressive du Français avec 400 exercices, Niveau avancé, CLE International.
4. Collectif, Besherelles : la Grammaire pour tous, Hatier.
5. Collectif, Besherelles : la Conjugaison pour tous, Hatier.
6. M. Grégoire, Grammaire progressive du Français avec 400 exercices, Niveau débutant, CLE International, 1997.
7. A. Hasni et al., La formation à l'enseignement des sciences et des technologies au secondaire, Presses de l'université du Québec, 2006.
8. J.-L. Lebrun, Guide pratique de la rédaction scientifique, EDP Sciences, 2007.
9. J.M. Robert, Difficultés du Français, Hachette,
10. C. Tisset, Enseigner la langue française à l'école : La Grammaire, L'Orthographe et la Conjugaison, Hachette Education, 2005.
11. J. Bossé-Andrieu, Abrégé des Règles de Grammaire et d'Orthographe, Presses de l'université du Québec, 2001.
12. J.-P. Colin, Le français tout simplement, Eyrolles, 2010.
13. Collectif, Test d'évaluation de Français, Hachette, 2001.
14. Y. Delatour et al., Grammaire pratique du Français en 80 fiches avec exercices corrigées, Hachette, 2000.
15. Ch. Descotes et al., L'Exercisier : l'expression française pour le niveau intermédiaire, Presses Universitaires de Grenoble, 1993.
16. H. Jaraush, C. Tufts, Sur le Vif, Heinle Cengage Learning, 2011.
17. J. Dubois et al, Les indispensables – Orthographe, Larousse, 2009.

Semester: 1
Teaching Unit: TU 1.1
Subject: English Language 1
Total Hours: 22h30 (Class: 1h30)
Credit: 1
Coefficient: 1

Objective:
Develop the reading, writing, listening and speaking abilities of the students.

Recommended prerequisites:
Basic English

Contents:
The English syl(Lab)us consists of a set of texts containing scientific and technical parts. The chosen texts must be used to study scientific and technical English and Grammar acquisition.
The texts must be selected according to the vocabulary built up, familiarization with both scientific and technical matters in English for further understanding. Therefore, each text will be defined by a set of vocabulary concepts, a set of special sentences (idioms) and comprehension questions.
The texts must contain also a terminology which means the translation of some words from English to French one. Besides, the activity at the end of each session must include a translation of long statements which are selected from the texts.

Examples for some lectures:	**Examples of Word Study: Patterns**
Iron and Steel Heat Treatment of Steel. Lubrication of Bearings. The Lathe. Welding. Steam Boilers. Steam Locomotives. Condensation and Condensers. Centrifugal Governors. Impulse Turbines. The Petro Engine. The Carburation System. The Jet Engine. The Turbo-Prop Engine. Aerofoil.	Make + Noun + Adjective Quantity, Contents Enable, Allow, Make, etc. + Infinitive Comparative, Maximum and Minimum The Use of Will, Can and May Prevention, Protection, etc., Classification The Impersonal Passive Passive Verb + By + Noun (agent) Too Much or Too Little Instructions (Imperative) Requirements and Necessity Means (by + Noun or –ing) Time Statements Function, Duty Alternatives

Assessment method:
100% Exam

Bibliographical references:

1. J. Upjohn, S. Blattes, V. Jans, Minimum Competence in Scientific English, Office des Publications Universitaires, 1994.
2. A.J. Herbert, The Structure of Technical English, Longman, 1972.
3. S. Berland-Delepine, Grammaire méthodique de l'anglais moderne avec exercices, Ophrys, 1982.
4. Test of English as a Foreign Language – Preparation Guide, Cliffs, 1991.
5. R. Fowler, The Little, Brown Handbook, Little, Brown Company, 1980.

6. Cambridge – First Certificate in English, Cambridge books, 2008.
7. K. Wilson, Th. Healy, First Choice, Oxford, 2007.
8. M. Mann, S. Tayore-Knowles, Destination : Grammar & Vocabulary with Answer Key, MacMillan, 2006.
9. E. Hamby, Ph. Bedford Robinson, Special English Computer Applications, Cassell, 1980.
10. P. Charles Brown, Norma D. Mullen, English for Computer Science, Oxford University Press, 1989.
11. Graeme Kennedy, Structure and Meaning in English: A Guide for Teachers, Pearson, 2004.
12. Anne M. Hanson, Brain-Friendly Strategies for Developing Student Writing Skills, 2nd Edition, Corwin Press, 2008.
13. Ann Bridges, How to Pass Higher English, Hodder Gibson-Hachette, 2009.
14. Claude Renucci, Anglais : 1000 Mots et expressions de la presse : Vocabulaire et expressions du monde économique, social et politique, Fernand Nathan, 2006.

Semester: 2
Teaching Unit: FU 1.2
Subject 1: Mathematics 2
TH/S: 67h30 (Class: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives::
Students will be gradually introduced to mathematics useful for their university curriculum. By the end of the course, the student should be able to solve first and second degree differential equations, solve integrals of rational, exponential, trigonometric, and polynomial functions, and solve systems of linear equations using various methods.

Recommended prerequisites:
Basic knowledge of mathematics (differential equations, integrals, systems of equations, etc.)

Content of the subject::

Chapter 1. Matrices and Determinants **((3 weeks))**
1-1 Matrices (definition, operation). 1-2 Matrix associated with a linear application. 1-3 Linear application associated with a matrix. 1-4 Change of basis, matrix of transition.

Chapter 2. Systems of Linear Equations **((2 weeks))**
2-1 Generalities. 2-2 Study of the set of solutions. 2-3 Methods of solving a linear system. Solution by Cramer's method. Solution by the method of inverse matrix. Solution by the Gauss method.

Chapter 3. Integrals **((4 weeks))**
3-1 Indefinite integral, property. 3-2 Integration of rational functions. 3-3 Integration of exponential and trigonometric functions. 3-4 The integral of polynomials. 3-5 Definite integration.

Chapter 4. Differential Equations **((4 weeks))**
4-1 Ordinary differential equations. 4-2 First-order differential equations. 4-3 Second-order differential equations. 4-4 Ordinary differential equations of the second order with constant coefficient.

Chapter 5. Functions of Several Variables **((2 weeks))**
5-1 Limit, continuity, and partial derivatives of a function. 5-2 Differentiability. 5-3 Double and triple integrals.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliography:
1- F. Ayres Jr, Théorie et Applications du Calcul Différentiel et Intégral - 1175 exercices corrigés, McGraw-Hill.
2- F. Ayres Jr, Théorie et Applications des équations différentielles - 560 exercices corrigés, McGraw-Hill.
3- J. Lelong-Ferrand, J.M. Arnaudiès, Cours de Mathématiques - Equations différentielles, Intégrales multiples, Tome 4, Dunod Université.
4- M. Krasnov, Recueil de problèmes sur les équations différentielles ordinaires, Edition de Moscou
5- N. Piskounov, Calcul différentiel et intégral, Tome 1, Edition de Moscou

6- J. Quinet, Cours élémentaire de mathématiques supérieures 3- Calcul intégral et séries, Dunod.
7- J. Quinet, Cours élémentaire de mathématiques supérieures 4- Equations différentielles, Dunod.
8- J. Quinet, Cours élémentaire de mathématiques supérieures 2- Fonctions usuelles, Dunod.
9- J. Quinet, Cours élémentaire de mathématiques supérieures 1- Algèbre, Dunod.
10- J. Rivaud, Algèbre : Classes préparatoires et Université Tome 1, Exercices avec solutions, Vuibert.
11- N. Faddeev, I. Sominski, Recueil d'exercices d'algèbre supérieure, Edition de Moscou.

Semester: 2
Teaching Unit: FU 1.2
Subject 2: Physics 2
TH/S: 67h30 (Class: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
Introduce the student to the physical phenomena underlying the laws of electricity in general.

Recommended prerequisites:
Mathematics 1, Physics 1.

Content of the subject::
Mathematical Review: (**(1 week)**)
1- Length, surface, volume elements in Cartesian, cylindrical, and spherical coordinate systems. Solid angle, Operators (gradient, curl, Nabla, Laplacian, and divergence).
2- Multiple derivatives and integrals.

Chapter I. Electrostatics: **((6 weeks))**
1- Electric charges and fields. Electrostatic interaction force-Coulomb's law.
2- Electric potential.
3- Electric dipole.
4- Electric field flux.
5- Gauss's theorem.
6- Conductors in equilibrium.
7- Electrostatic pressure.
8- Capacitance of a conductor and a capacitor.

Chapter II. Electrodynamics: **((4 weeks))**
1- Electrical conductor.
2- Ohm's law.
3- Joule's law.
4- Electrical circuits.
5- Application of Ohm's law to networks.
6- Kirchhoff's laws. Thevenin's theorem.

Chapter III. Electromagnetism: **((4 weeks))**
1- Magnetic field: Definition of a magnetic field, Biot-Savart's law, Ampere's theorem, Calculation of magnetic fields created by permanent currents.
2- Induction phenomena: Induction phenomena (circuit in a variable magnetic field and moving circuit in a permanent magnetic field), Lorentz force, Laplace force, Faraday's law, Lenz's law, Application to coupled circuits.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:
1. J.-P. Perez, R. Carles, R. Fleckinger ; Electromagnétisme Fondements et Applications, Ed. Dunod, 2011.
2. H. Djelouah ; Electromagnétisme ; Office des Publications Universitaires, 2011.

3. P. Fishbane et al. ; Physics For Scientists and Engineers with Modern Physics, 3rd ed. ; 2005.
4. P. A. Tipler, G. Mosca ; Physics For Scientists and Engineers, 6th ed., W. H. Freeman Company, 2008.

Semester: 2
Teaching Unit: FU 1.2
Subject 3: Thermodynamics
TH/S: 67h30 (Class: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives::
To provide the necessary foundations of classical thermodynamics for combustion and thermal machine applications. To standardize students' knowledge. The skills to be acquired are: Acquisition of a scientific foundation in classical thermodynamics; Application of thermodynamics to various systems; Statement, explanation, and understanding of the fundamental principles of thermodynamics.

Recommended prerequisites:
Basic mathematics.

Content of the subject::
Chapter 1. Generalities on Thermodynamics **((3 weeks))**
1- Fundamental properties of state functions. 2- Definitions of thermodynamic systems and the external environment. 3- Description of a thermodynamic system. 4- Evolution and thermodynamic equilibrium states of a system. 5- Possible transfers between the system and the external environment. 6- State transformations of a system (operation, evolution). 7- Reminder of the laws of perfect gases.

Chapter 2. The 1st Law of Thermodynamics: **((3 weeks))**

Work, heat, internal energy, Notion of conservation of energy. 2. The 1st law of thermodynamics: statement, notion of internal energy of a system, application to a perfect gas, the enthalpy function, heat capacity, reversible transformations (isochoric, isobaric, isothermal, adiabatic).
Chapter 3. Applications of the first law of thermodynamics to thermochemistry
((3 weeks))
Reaction heats, standard state, standard enthalpy of formation, enthalpy of dissociation, enthalpy of phase change, enthalpy of a chemical reaction, Hess's law, Kirchhoff's law.

Chapter 4. The 2nd Law of Thermodynamics **((3 weeks))**
1- The 2nd law for a closed system. 2. Statement of the 2nd law: entropy of a closed isolated system. 3. Calculation of entropy change: reversible isothermal transformation, reversible isochoric transformation, reversible isobaric transformation, adiabatic transformation, during a change of state, during a chemical reaction.

Chapter 5. The 3rd Law and absolute entropy (**(1 week)**)

Chapter 6. Free energy and enthalpy – Criteria for the evolution of a system **((2 weeks))**
1- Introduction. 2- Free energy and enthalpy. 3- Chemical equilibria.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:

1. C. Coulon, S. Le Boiteux S. et P. Segonds, Thermodynamique Physique - Cours et exercices avec solutions, Edition Dunod.
2. H.B. Callen, Thermodynamics, Cours, Edition John Wiley and Sons, 1960
3. R. Clerac, C. Coulon, P. Goyer, S. Le Boiteux & C. Rivenc, Thermodynamics, Cours et travaux dirigés de thermodynamique, Université Bordeaux 1, 2003
4. O. Perrot, Cours de Thermodynamique I.U.T. de Saint-Omer Dunkerque, 2011
5. C. L. Huillier, J. Rous, Introduction à la thermodynamique, Edition Dunod.

Semester: 2
Teaching unit: MU 1.2
Subject 1: Physics 2 (Lab)
TH/S: 45h00 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
To consolidate theoretical concepts covered in the Physics 2 course through practical (Lab) sessions.

Recommended prerequisites:
Mathematics 1, Physics 1.

Content of the subject::
At least 5 experiments (3h00 / 15 days):

Presentation of measurement instruments and tools (Voltmeter, Ammeter, Rheostat, Oscilloscopes, Generator, etc.).
Kirchhoff's laws (loop and node laws).
Thevenin's theorem.
Inductance and capacitance association and measurement.
Charging and discharging of a capacitor.
Oscilloscope.
(Lab) on magnetism.

Assessment method:
Continuous control: 100%.

Semester: 2
Teaching Unit: MU 1.2
Subject 2: Chemistry 2 (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Consolidate the theoretical concepts covered in the Thermodynamics course through (Lab)oratory sessions.

Recommended prerequisites:
Thermodynamics.

Content of the subject::

Ideal gas laws.
Water value of the calorimeter.
Specific heat: specific heat of liquid and solid substances.
Latent heat: latent heat of fusion of ice.
Reaction heat: Determination of the energy released by a chemical reaction (HCl/NaOH).
Hess's law.
Vapor pressure of a solution.

Assessment method:
Continuous control: 100%

Semester: 2
Teaching unit: MU 1.2
Course 3: Computer Science 2
TH/S: 45h00 (Class: 1h30, PW: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives::
To master the basic techniques in programming and algorithmics. To acquire the fundamental concepts of computer science. The skills to be acquired are: programming with a certain degree of autonomy; designing algorithms from simple to relatively complex.

Recommended prerequisites:
Knowing how to use the university website, file systems, Windows user interface, programming environment.

Content of the subject::

Chapter 1. Indexed Variables **((4 weeks))**

One-dimensional arrays: representation in memory, operations on arrays.
Two-dimensional arrays: representation in memory, operations on two-dimensional arrays.
Chapter 2. Functions and Procedures **((6 weeks))**

Functions: types of functions, function declaration, function calls.
Procedures: global and local variable concepts, simple procedures, procedures with arguments.
Chapter 3. Records and Files **((5 weeks))**

Heterogeneous data structures.
Structure of a record (notion of fields).
Manipulation of record structures.
Notion of a file.
File access modes.
Reading and writing to a file.
Computer Science 2 PW:
Several practical work sessions will be planned to implement the programming techniques covered during the course.

Application PW of programming techniques covered in class.
Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:
1- Les algorithmes pour les Nuls grand format Livre de John Paul Mueller (Informatiker, USA) et Luca Massaron 2017
2- Algorithmique: cours avec 957 exercices et 158 problèmes Livre de Charles E. Leiserson, Clifford Stein et Thomas H. Cormen 2017
3- Algorithmes: Notions de base Livre de Thomas H. Cormen 2013.

Semester: 2
Teaching unit: MU 1.2
Subject 4: Methodology of Presentation
TH/S: 15 (Class: 1h00)
Credits: 1
Coefficient: 1

Teaching objectives::
To provide the main foundations for successful oral presentations. Among the skills to be acquired: knowing how to prepare a presentation, knowing how to deliver a presentation, knowing how to capture the audience's attention, being aware of the pitfalls of plagiarism, and understanding the regulations of intellectual property.

Recommended prerequisites::
Techniques of expression and communication, and methodology of writing.

Content of the subject::

Chapter 1. Oral presentation **((3 weeks))**
Communication. Preparation of an oral presentation. Different types of outlines.

Chapter 2. Presentation of an oral presentation **((3 weeks))**
Structure of an oral presentation. Delivery of an oral presentation.

Chapter 3. Plagiarism and Intellectual Property **((3 weeks))**
1- Plagiarism: Definitions of plagiarism, penalties for plagiarism, how to borrow works from other authors, citations, illustrations, how to avoid plagiarism.
2- Writing a bibliography: Definition, objectives, how to present a bibliography, writing a bibliography.

Chapter 4. Presenting a written work **((6 weeks))**
Presenting a written work. Applications: presentation of an oral presentation.

Assessment method:
Exam : 100%.

Bibliographical Bibliographical references:
1. M. Fayet, Méthodes de communication écrite et orale, 3e édition, Dunod, 2008.
2. M. Kalika, Mémoire de master – Piloter un mémoire, Rédiger un rapport, Préparer une soutenance, Dunod, 2016.
3. M. Greuter, Réussir son mémoire et son rapport de stage, l'Etudiant, 2014
4. B. Grange, Réussir une présentation. Préparer des slides percutants et bien communiquer en public. Eyrolles, 2009.
5. H. Biju-Duval, C. Delhay, Tous orateurs, Eyrolles, 2011.
6. C. Eberhardt, Travaux pratiques avec PowerPoint. Créer et mettre en page des diapositives, Dunod, 2014.
7. F. Cartier, Communication écrite et orale, Edition GEP- Groupe Eyrolles, 2012.
8. L. Levasseur, 50 exercices pour prendre la parole en public, Eyrolles, 2009.
9. S. Goodlad, Speaking technically – A Handbook for Scientists, Engineers, and Physicians on How to Improve Technical Presentations, Imperial College Press, 2000.
10. M. Markel, Technical communication, eleventh edition, Bedford/St Martin's, 2015.

Semester: 2
Teaching Unit: DU 1.2
Subject 1: Careers in Science and Technology 2
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Subject objective:
To introduce the student, in a first step, to all the fields covered by the Science and Technology domain, and in a second step, to a range of careers that result from these fields. In the same context, this subject introduces the student to the new challenges of sustainable development and the new careers that may arise from it.

Recommended prerequisites:
None.

Content of the subject::

Industrial Hygiene and Safety (IHS) and Mining Engineering Fields: **((2 weeks))**
Definitions and areas of application (safety of property and people, environmental problems, exploration and exploitation of mineral resources, etc.)
Role of the specialist in these fields.
HVAC and Transportation Engineering Fields: **((2 weeks))**
Definitions and areas of application (air conditioning, smart buildings, transportation safety, traffic management and road, air, and naval transport, etc.)
Role of the specialist in these fields.
Civil Engineering, Hydraulic Engineering and Public Works Fields: **((2 weeks))**
Definitions and areas of application (construction materials, major road and rail infrastructures, bridges, airports, dams, drinking water supply and sanitation, hydraulic flows, water resource management, public works and territorial development, smart cities, etc.)
Role of the specialist in these fields.
Aerospace, Mechanical Engineering, Maritime Engineering and Metallurgy Fields: **((2 weeks))**
Definitions and areas of application (aerospace, avionics, automotive industry, ports, dikes, production of industrial equipment, steel industry, metal transformation, etc.)
Role of the specialist in these fields.
Approaches to Sustainable Production: **((2 weeks))**
Industrial ecology, remanufacturing, eco-design.

Measuring the Sustainability of a Process/Product/Service: **((2 weeks))**
Environmental analysis, life cycle assessment (LCA), carbon fooPWrint, case studies/applications.

Sustainable Development and Enterprise: **((3 weeks))**
Definition of the company as an economic entity (notions of profit, costs, performance) and a social entity (notion of social/corporate responsibility of the company), Impact of economic activities on the environment (examples), Issues/benefits of SD for the company, Means of engagement in an SD approach (e.g. ISO 14001 certification, (Lab)eling (e.g. energy (Lab)eling, Eco(Lab)el, Bio/AB (Lab)el, FSC (Lab)el, etc.), SD strategic plan, Global Reporting Initiative (GRI)…), Rankings of the world's most sustainable companies (Dow Jones Sustainable Index, Global 100, etc.), Case studies of high-performing/eco-responsible companies in ST sectors (e.g. SIEMENS, Cisco, Henkel AG & Co, TOTAL, Peugeot, Eni SPA...).

Personal work of the student for this subject:

Work in groups/pairs: Reading articles on sustainable development and/or reports of high-performing and sustainable companies and preparing summaries of the main actions taken in the field of SD.
Examples of documents for reading and summarizing:
Case of ONA and ENIEM: Kadri, Mouloud, 2009, Sustainable development, the company and ISO 14001 certification, Marché et organisations vol. 1 (N° 8), p. 201-215 (freely accessible online: htPW://www.cairn.info/revue-marche-et-organisations-2009-1-page-201.htm)
Mireille Chiroleu-Assouline. Sustainable development strategies of companies. Idées, La revue des sciences économiques et sociales, CNDP, 2006, p 32-39 (freely accessible online: htPW://halshs.archives-ouvertes.fr/hal-00306217/document)
Web page on TOTAL's environmental and societal commitments: htPWs://www.total.com/fr/engagement
Sustainable mobility innovations of the PSA group: htPW://www.rapportannuel.groupe-psa.com/rapport-2015/engagements/dessolutions-innovantes-pour-des-transports-durables/

Assessment method:
Exam: 100%.

Bibliographical Bibliographical references:

1- V. Maymo et G. Murat, La boîte à outils du Développement durable et de la RSE- 53 outils et méthodes, Edition : Dunod, 2017.
2- P. JacqMUot et V. Bedin, Le dictionnaire encyclopédique du développement durable, Edition : Sciences Humaines, 2017.
3- Y. Veyret, J. Jalta et M. Hagnerelle, Développements durables : Tous les enjeux en 12 leçons, Edition : Autrement, 2010.
4- L. Grisel et Ph. Osset, L'Analyse du cycle de vie d'un produit ou d'un service: Applications et mise en pratique, 2eme Edition : AFNOR, 2008.
5- Sh. Shaked, N. Jolliet-Gavin, P. Crettaz, M. Saadé-Sbeih et O. Jolliet, Analyse du cycle de vie: Comprendre et réaliser un écobilan, 3eme Edition : PPUR, 2017.
6- G. Pitron et H. Védrine, La guerre des métaux rares : La face cachée de la transition énergétique et numérique, Edition : Liens qui libèrent, 2018.
7- Les métiers de l'environnement et du développement durable, Collection : Parcours, Edition : ONISEP, 2015.

Semester: 2
Teaching unit: TU 1.2
Subject 1: French Language 2
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
The objective of this subject is to develop the following four skills: Oral comprehension, written comprehension, oral expression and written expression through reading and studying texts.

Recommended prerequisites:
Basic French.

Content of the subject::
We propose below a range of themes that cover fundamental sciences, technologies, economics, social events, communication, sports, health, etc. The teacher can choose from this list of texts to develop during the class. Otherwise, he is free to address other themes of his choice. Texts can be taken from various communication media such as daily newspapers, sports or entertainment magazines, specialized or popular science journals, books, websites, audio and video recordings, etc.
For each text, the teacher helps the student to develop their language skills: listening, comprehension, oral and written expression. In addition, he must use this text to identify the grammatical structures that he will develop during the same class session. We remind here, by way of illustration, a set of grammatical structures that can be developed as examples. Of course, it is not necessary to develop all of them or in the same way. Some can be recalled and others detailed extensively.

Examples of themes	Grammatical structures
The pharmaceutical industry The agri-food industry The national employment agency ANEM Sustainable development Renewable energies Biotechnology Stem cells Road safety Dams Water - Water resources Avionics Automotive electronics Electronic newspapers Carbon 14 dating Violence in stadiums Drug addiction: a social scourge Smoking School failure The Algerian War Social networks	The subjunctive. The conditional. The imperative. The past participle. The passive form. Possessive adjectives, Possessive pronouns. Demonstratives, Demonstrative pronouns. Expression of quantity (several, some, enough, much, more, less, as much, ...). Numbers and measurements. Pronouns 'who, whom, where, whose'. Subordinate temporal prepositions. Cause, Consequence. Purpose, Opposition, Condition. Comparatives, Superlatives. ...

China, an economic power Superconductivity Cryptocurrency Advertising Autism	

Assessment method:

Exam: 100%.

Bibliographical Bibliographical references:

1. M. Badefort, Objectif : Test de Français International, Edulang, 2006.
2. O. Bertrand, I. Schaffner, Réussir le TCF, Exercices et activités d'entrainement, Les éditions de l'école polytechnique, 2009.
3. M. Boulares, J.-L. Frerot, Grammaire progressive du Français avec 400 exercices, Niveau avancé, CLE International.
4. Collectif, Besherelles : la Grammaire pour tous, Hatier.
5. Collectif, Besherelles : la Conjugaison pour tous, Hatier.
6. M. Grégoire, Grammaire progressive du Français avec 400 exercices, Niveau débutant, CLE International, 1997.
7. A. Hasni et al., La formation à l'enseignement des sciences et des technologies au secondaire, Presses de l'université du Québec, 2006.
8. J.-L. Lebrun, Guide pratique de la rédaction scientifique, EDP Sciences, 2007.
9. J.M. Robert, Difficultés du Français, Hachette,
10. C. Tisset, Enseigner la langue française à l'école : La Grammaire, L'Orthographe et la Conjugaison, Hachette Education, 2005.
11. J. Bossé-Andrieu, Abrégé des Règles de Grammaire et d'Orthographe, Presses de l'université du Québec, 2001.
12. J.-P. Colin, Le français tout simplement, Eyrolles, 2010.
13. Collectif, Test d'évaluation de Français, Hachette, 2001.
14. Y. Delatour et al., Grammaire pratique du Français en 80 fiches avec exercices corrigees, Hachette, 2000.
15. Ch. Descotes et al., L'Exercisier : l'expression française pour le niveau intermédiaire, Presses Universitaires de Grenoble, 1993.
16. H. Jaraush, C. Tufts, Sur le Vif, Heinle Cengage Learning, 2011.
17. J. Dubois et al., Les indispensables – Orthographe, Larousse, 2009.

Semester: 2
Teaching unit: TU 1.2
Subject 1: Langue Anglaise 2
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Develop the reading, writing, listening and speaking abilities of the students.

Recommended prerequisites:
Basic English.

Content of the subject::
The English syl(Lab)us consists of a set of texts containing scientific and technical parts. The chosen texts must be used to study scientific and technical English and Grammar acquisition.
The texts must be selected according to the vocabulary built up, familiarization with both scientific and technical matters in English for further understanding. Therefore, each text will be defined by a set of vocabulary concepts, a set of special sentences (idioms) and comprehension questions.
The texts must contain also a terminology which means the translation of some words from English to French one. Besides, the activity at the end of each session must include a translation of long statements which are selected from the texts.

Examples for some lectures:	**Examples of Word Study: Patterns**
Radioactivity. Chain Reaction. Reactor Cooling System. Conductor and Conductivity. Induction Motors. Electrolysis. Liquid Flow and Metering. Liquid Pumps. Petroleum. Road Foundations. Rigid Pavements. Piles for Foundations. Suspension Bridges.	Explanation of Cause Result Conditions (if), Conditions (Restrictive) Eventuality Manner When, Once, If, etc. + Past Participle It is + Adjective + to As It is + Adjective or Verb + that… Similarity, Difference In Spite of, Although Formation of Adjectives Phrasal Verbs

Assessment method:
Exam : 100%.

Bibliographical references:

1. J. Upjohn, S. Blattes, V. Jans, Minimum Competence in Scientific English, Office des Publications Universitaires, 1994.
2. A.J. Herbert, The Structure of Technical English, Longman, 1972.
3. S. Berland-Delepine, Grammaire méthodique de l'anglais moderne avec exercices, Ophrys, 1982.
4. Test of English as a Foreign Language – Preparation Guide, Cliffs, 1991.
5. R. Fowler, The Little, Brown Handbook, Little, Brown Company, 1980.
6. Cambridge – First Certificate in English, Cambridge books, 2008.
7. K. Wilson, Th. Healy, First Choice, Oxford, 2007.

8. M. Mann, S. Tayore-Knowles, Destination : Grammar & Vocabulary with Answer Key, MacMillan, 2006.
9. E. Hamby, Ph. Bedford Robinson, Special English Computer Applications, Cassell, 1980.
10. P. Charles Brown, Norma D. Mullen, English for Computer Science, Oxford University Press, 1989.
11. Graeme Kennedy, Structure and Meaning in English: A Guide for Teachers, Pearson, 2004.
12. Anne M. Hanson, Brain-Friendly Strategies for Developing Student Writing Skills, 2nd Edition, Corwin Press, 2008.
13. Ann Bridges, How to Pass Higher English, Hodder Gibson-Hachette, 2009.
14. Claude Renucci, Anglais : 1000 Mots et expressions de la presse : Vocabulaire et expressions du monde économique, social et politique, Fernand Nathan, 2006.

Semester: 3
Teaching Unit: FU 2.1.1
Subject 1: Mathematics 3
TH/S: 67h30 (Class: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
By the end of this course, the student should be able to know the different types of series and their convergence conditions as well as the different types of convergence.
Recommended prerequisites:
Mathematics 1 and Mathematics 2

Content of the subject::
Chapter 1. Simple and multiple integrals **(3 weeks)**
1.1 Review of Riemann integral and primitive calculation. 1.2 Double and triple integrals.
1.3 Application to area and volume calculations, …

Chapter 2. Improper integrals **(2 weeks)**
2.1 Integrals of functions defined on an unbounded interval. 2.2 Integrals of functions defined on a bounded interval, infinite at one end.

Chapter 3. Differential equations **(2 weeks)**
3.1 Review of ordinary differential equations. 3.2 Partial differential equations. 3.3 Special functions.

Chapter 4. Series **(3 weeks)**
4.1 Numerical series. 4.2 Sequences and series of functions. 4.3 Power series, Fourier series.

Chapter 5. Fourier transform **(3 weeks)**
5.1 Definition and properties. 5.2 Application to the solution of differential equations.

Chapter 6. Laplace transform **(2 weeks)**
6.1 Definition and properties. 6.2 Application to the solution of differential equations.

Assessment mode:
Continuous control: 40%; Final exam: 60%.

Bibliographical Bibliographical references:
1- F. Ayres Jr, Théorie et Applications du Calcul Différentiel et Intégral - 1175 exercices corrigés, McGraw-Hill.
2- F. Ayres Jr, Théorie et Applications des équations différentielles - 560 exercices corrigés, McGraw-Hill.
3- J. Lelong-Ferrand, J.M. Arnaudiès, Cours de Mathématiques - Equations différentielles, Intégrales multiples, Tome 4, Dunod Université.
4- M. Krasnov, Recueil de problèmes sur les équations différentielles ordinaires, Edition de Moscou
5- N. Piskounov, Calcul différentiel et intégral, Tome 1, Edition de Moscou
6- J. Quinet, Cours élémentaire de mathématiques supérieures 3- Calcul intégral et séries, Dunod.
7- J. Quinet, Cours élémentaire de mathématiques supérieures 4- Equations différentielles, Dunod.
8- M. R. Spiegel, Transformées de Laplace, Cours et problèmes, 450 Exercices corrigés, McGraw-Hill.

Semester: 3
Teaching unit: FU 2.1.1
Subject 2: Waves and Vibrations
TH/S: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Introduce the student to mechanical vibration phenomena limited to low amplitude oscillations for 1 or 2 degrees of freedom as well as the study of the propagation of mechanical waves.

Recommended prerequisites:
Mathematics 2, Physics 1, and Physics 2

Content of the subject::
Preamble: This subject is divided into two parts, Waves, and Vibrations, which can be approached independently of each other. Regarding this and due to the consistency of the subject in terms of content, it is advisable to approach this subject in this order: Waves and then Vibrations for students in the Electrical Engineering (Group A) programs. While for students in Groups B and C (Civil Engineering, Mechanical Engineering, and Process Engineering), it is advisable to start with Vibrations. In any case, the teacher is called upon to do his best to cover both parts. We remind that this subject is intended for engineering professions in the field of Science and Technology. Also, the teacher is requested to overlook all parts of the course that require demonstrations or theoretical developments and to focus only on practical aspects. However, the demonstrations can be the subject of auxiliary work to be assigned to students as activities within the framework of student's personal work. Please refer to the paragraph "G- Evaluation of the student through Continuous Assessment and Personal Work" in this training offer regarding this.

Part A: Vibrations
Chapter 1. Introduction to Lagrange Equations **(2 weeks)**
1.1 Lagrange Equations for a particle
1.1.1 Lagrange Equations
1.1.2 Case of conservative systems
1.1.3 Case of velocity-dependent friction forces
1.1.4 Case of an external force dependent on time
1.2 System with several degrees of freedom.

Chapter 2. Free oscillations of single degree of freedom systems **(2 weeks)**
2.1 Un-damped oscillations
2.2 Free oscillations of damped systems

Chapter 3. Forced oscillations of single degree of freedom systems **(1 week)**
3.1 Differential equation
3.2 Mass-spring-damper system
3.3 Solution of the differential equation
3.3.1 Harmonic excitation
3.3.2 Periodic excitation
3.4 Mechanical impedance
Chapter 4. Free oscillations of two degrees of freedom systems **(1 week)**
4.1 Introduction
4.2 Two-degree of freedom systems

Chapter 5. Forced oscillations of two degrees of freedom systems **(2 weeks)**
5.1 Lagrange Equations
5.2 Mass-spring-damper systems
5.3 Impedance
5.4 Applications
5.5 Generalization to systems with n degrees of freedom

Part B: Waves
Chapter 1. One-dimensional propagation phenomena **(2 weeks)**
1.1 Generalities and basic definitions
1.2 Propagation equation
1.3 Solution of the propagation equation
1.4 Sinusoidal progressive wave
1.5 Superposition of two sinusoidal progressive waves

Chapter 2. Vibrating strings **(2 weeks)**
2.1 Wave equation
2.2 Harmonic progressive waves
2.3 Free oscillations of a string of finite length
2.4 Reflection and transmission

Chapter 3. Acoustic Waves in Fluids **(1 week)**
3.1 Wave Equation
3.2 Speed of Sound
3.3 Sinusoidal Progressive Wave
3.4 Reflection-Transmission

Chapter 4. Electromagnetic Waves **(2 weeks)**
4.1 Wave Equation
4.2 Reflection-Transmission
4.3 Different Types of Electromagnetic Waves

Assessment method:
Continuous control: 40%; Final Exam: 60%.

Bibliographical Bibliographical references:

1. H. Djelouah ; Vibrations et Ondes Mécaniques – Cours & Exercices (site de l'université de l'USTHB : perso.usthb.dz/~hdjelouah/Coursvom.html)
2. T. Becherrawy ; Vibrations, ondes et optique ; Hermes science Lavoisier, 2010
3. J. Brac ; Propagation d'ondes acoustiques et élastiques ; Hermès science Publ. Lavoisier, 2003.
4. R. Lefort ; Ondes et Vibrations ; Dunod, 2017
5. J. Bruneaux ; Vibrations, ondes ; Ellipses, 2008.
6. J.-P. Perez, R. Carles, R. Fleckinger ; Electromagnétisme Fondements et Applications, Ed. Dunod, 2011.
5. H. Djelouah ; Electromagnétisme ; Office des Publications Universitaires, 2011.

Semester: 3
Teaching unit: FU 2.1.2
Subject 1: Fluid Mechanics
TH/S : 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objective:
Introduce the student to the field of fluid mechanics, with a detailed study of fluid statics in the first part. The study of non-viscous fluid motion will then be considered in the second part, and finally the motion of real fluids will be studied.

Recommended prerequisites:

Content of the subject::

Chapter 1. Properties of Fluids **((3 weeks))**

Physical definition of a fluid: States of matter, divided matter (dispersion, suspensions, emulsions)
Perfect fluid, real fluid, compressible fluid, and incompressible fluid.
Mass density, density
Rheology of a fluid, viscosity of fluids, surface tension of a fluid
Chapter 2. Fluid Statics **((4 weeks))**

Definition of pressure, pressure at a point in a fluid
Fundamental law of fluid statics
Level surface
Pascal's theorem
Calculation of pressure forces: Flat plate (horizontal, vertical, oblique), center of thrust, static pressure measurement instruments, measurement of atmospheric pressure, barometer, Torricelli's law
Pressure for non-miscible superimposed fluids
Chapter 3. Dynamics of Incompressible Perfect Fluids **((4 weeks))**

Steady flow
Continuity equation
Mass flow rate and volume flow rate
Bernoulli's theorem, case without work exchange and with work exchange
Applications to flow and velocity measurements: Venturi, Diaphragms, Pitot tubes, etc.
Euler's theorem
Chapter 4. Dynamics of Incompressible Real Fluids **((4 weeks))**

Flow regimes, Reynolds experiment
Dimensional analysis, Vashy-Buckingham theorem, Reynolds number
Linear pressure losses and singular pressure losses, Moody diagram.
Generalization of Bernoulli's theorem to real fluids

Assessment method:
Continuous control: 40%; Final exam: 60%.

Bibliographical Bibliographical references:

(According to the avai(Lab)ility of documentation at the institution, websites, etc.)

1- Fundamentals of fluid mechanics 6th Edition, 2009, BR Munson, DF Young TH Okiishi, WW Huebsch 6th Edition John Wiley & Sons

2- Fluid mechanics, YA Cengel - 2010 - Tata McGraw-Hill Education

3- Fluid Mechanics Frank M. White Fourth Edition 2003 McGraw-Hill

4- Mécanique des fluids et hydraulique 2ème édition, Ronald v. Giles, Jack B Evett, Cheng Liu, McGraw-Hill

5- S. Amiroudine, J. L. Battaglia, 'Mécanique des fluides Cours et exercices corrigés'Ed. Dunod

6- R. Comolet, 'Mécanique des fluides expérimentale', Tome 1, 2 et 3, Ed. Masson et Cie.

7- R. Ouziaux, 'Mécanique des fluides appliquée', Ed. Dunod, 1978

8- B. R. Munson, D. F. Young, T. H. Okiishi, 'Fundamentals of fluid mechanics', Wiley & sons.
R. V. Gilles, 'Mécanique des fluides et hydraulique : Cours et problèmes', Série Schaum, Mc Graw Hill, 1975.

Semester: 3
Teaching unit: FU 2.1.2
Subject 2: Rational Mechanics
TH/S: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
The student will be able to understand the nature of a problem (static, kinematic, or dynamic) in solid mechanics and will have the necessary tools to solve it within the framework of classical mechanics. This subject is a prerequisite for the courses on Strength of Materials and Analytical Mechanics.

Recommended prerequisites:
The student should have a prior understanding of Physics 1, which covers point mechanics. Also, Mathematics 2 includes essential tools.

Content of the subject::

Chapter 1. Mathematical review (vector calculus elements) - **(1 week)**

Chapter 2. Generalities and basic definitions - **(2 weeks)**
2.1 Definition and physical meaning of force
2.2 Mathematical representation of force
2.3 Operations on force (composition, decomposition, projection)
2.4 Types of force: punctual, linear, surface, volumetric
2.5 Classification of forces: internal forces, external forces.
2.6 Mechanical models: point particle, solid body

Chapter 3. Statics - **(3 weeks)**
3.1 Axioms of statics
3.2 Constraints, supports, and reactions
3.3 Axiom of constraints
3.4 Equilibrium conditions:
3.4.1 Concurrent forces
3.4.2 Parallel forces
3.4.3 Coplanar forces

Chapter 4. Kinematics of rigid bodies - **(3 weeks)**
4.1 Brief review of kinematic quantities for a point particle.
4.2 Kinematics of a rigid body
4.2.1 Translation motion
4.2.2 Rotation motion about a fixed axis
4.2.3 Planar motion
4.2.4 Composite motion.

Chapter 5. Mass geometry - **(3 weeks)**
5.1 Mass of a material system
5.1.1 Continuous system
5.1.2 Discrete system
5.2 Integral formulation of the center of mass

5.2.1 Definitions (linear, surface, and volumetric cases)
5.2.2 Discrete formulation of the center of mass
5.2.3 GULDIN theorems
5.3 Moment and inertia product of solids
5.4 Inertia tensor of a solid
5.4.1 Particular cases
5.4.2 Principal axes of inertia
5.5 Huyghens' theorem
5.6 Moment of inertia of solids about an arbitrary axis.

Chapter 6. Dynamics of rigid bodies - **(3 weeks)**
6.1 Brief review of dynamic quantities for a point particle.
6.2 Element of kinetics of rigid body:
6.2.1 Momentum
6.2.2 Angular momentum
6.2.3 Kinetic energy
6.3 Equations of motion for a solid body
6.4 Theorem of angular momentum
6.5 Theorem of kinetic energy
6.6 Applications:
6.6.1 Pure translation case
6.6.2 Rotation case about a fixed axis
6.6.3 Combined case of translation and rotation.

Assessment method:
Continuous control: 40%; Final exam: 60%.

Bibliographical references:
(According to the avai(Lab)ility of documentation at the institution, websites, etc.)
1. Éléments de Mécanique rationnelle. S. Targ. Editions Mir Moscou
2. Mécanique à l'usage des ingénieurs. STATIQUE. Edition Russell. Ferdinand P. Beer
3. Mécanique générale. Cours et exercices corrigés. Sylvie Pommier. Yves Berthaud. DUNOD.
4. Mécanique générale - Théorie et application, Editions série. MURAY R. SPIEGEL schaum, 367p.
5. Mécanique générale – Exercices et problèmes résolus avec rappels de cours, Office des publications Universitaires, Tahar HANI 1983, 386p.

Semester: 3
Teaching unit: MU 2.1
Subject 1: Probability & Statistics
TH/S: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
This module allows students to learn the essential concepts of probability and statistics, namely: statistical series with one and two variables, probability on a finite universe, and random variables.

Recommended prerequisites::
Mathematics 1 and Mathematics 2

Content of the subject::
Part A: Statistics
Chapter 1. Basic definitions (**(1 week)**)
A.1.1 Concepts of population, sample, variables, modalities
A.1.2 Different types of statistical variables: qualitative, quantitative, discrete, continuous.

Chapter 2. Statistical series with one variable **((3 weeks))**
A.2.1 Number of cases, frequency, percentage.
A.2.2 Cumulative number of cases, cumulative frequency.
A.2.3 Graphical representations: bar chart, pie chart, stem-and-leaf plot, frequency polygon (and frequency curve). Histogram. Cumulative curves.
A.2.4 Measures of position.
A.2.5 Measures of dispersion: range, variance and standard deviation, coefficient of variation.
A.2.6 Measures of shape.

Chapter 3. Statistical series with two variables **((3 weeks))**
A.3.1 Data tables (contingency table). Scatter plot.
A.3.2 Marginal and conditional distributions. Covariance.
A.3.3 Linear correlation coefficient. Regression line and Mayer line.
A.3.4 Regression curves, regression band, and correlation ratio.
A.3.5 Functional adjustment.

Part B: Probability
Chapter 1. Combinatorics (**(1 week)**)
B.1.1 Arrangements.
B.1.2 Combinations.
B.1.3 Permutations.

Chapter 2. Introduction to probability **((2 weeks))**
B.2.1 Algebra of events.
B.2.2 Definitions.
B.2.3 Probabilistic spaces.
B.2.4 General theorems of probabilities.

Chapter 3. Conditioning and independence (**(1 week)**)
B.3.1 Conditioning.
B.3.2 Independence.

B.3.3 Bayes' theorem.

Chapter 4. Random variables (**(1 week)**)
B.4.1 Definitions and properties.
B.4.2 Distribution function.
B.4.3 Mathematical expectation.
B.4.4 Covariance and moments.

Chapter 5. Standard discrete and continuous probability distributions **((3 weeks))**
Bernoulli, binomial, Poisson, ...; Uniform, normal, exponential,...

Assessment method:
Continuous control: 40%; Final exam: 60%.

Bibliographical Bibliographical references::
1. D. Dacunha-Castelle and M. Duflo. Probabilités et statistiques : Problèmes à temps fixe. Masson, 1982.
2. J.-F. Delmas. Introduction au calcul des probabilités et à la statistique. Polycopié ENSTA, 2008.
3. W. Feller. an Introduction to Probability Theory and its Applications, Volume 1. Wiley & Sons, Inc., 3rd edition, 1968.
4. G. Grimmett, D. Stirzaker, Probability and Random Processes, Oxford University Press, 2nd edition, 1992.
5. J. Jacod and P. Protter, Probability Essentials, Springer, 2000.
6. A. Montfort. Cours de statistique mathématique. Economica, 1988.
7. A. Montfort. Introduction à la statistique. Ecole Polytechnique, 1991

Semester: 3
Teaching Unit: MU 2.1
Subject 2: Computer Science 3
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
To teach students programming using easily accessible software (mainly: Mat(Lab), Sci(Lab), Mapple...). This subject will be a tool for the implementation of numerical methods PW in S4.
Recommended prerequisites::
Basic programming skills acquired in Computer Science 1 and 2.

Content of the subject::
Practical Work 1: Presentation of a scientific programming environment (Mat(Lab), Sci(Lab), etc.) **(1 week)**
Practical Work 2: Script files and types of data and variables **(2 weeks)**
Practical Work 3: Reading, displaying and saving data **(2 weeks)**
Practical Work 4: Vectors and matrices **(2 weeks)**
Practical Work 5: Control statements (for and while loops, if and switch statements) **(2 weeks)**
Practical Work 6: Function files **(2 weeks)**
Practical Work 7: Graphics (Management of graphic windows, plot) **(2 weeks)**
Practical Work 8: Use of toolboxes **(2 weeks)**

Assessment method: Continuous control: 100%.

Bibliographical Bibliographical references::
(According to the avai(Lab)ility of documentation at the institution, websites, etc.)
1- Informatique: Programmation et simulation en Sci(Lab) 2014 - Auteurs : Arnaud Bégyn, Jean-Pierre Grenier, Hervé Gras.

2- Sci(Lab) : De la théorie à la pratique - I. Les fondamentaux. Livre de Philippe Roux 2013.

Semester: 3
Teaching unit: MU 2.1
Subject 3: Technical Drawing
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
This course will enable students to acquire the principles of representing parts in industrial drawing. Furthermore, this subject will allow students to represent and read plans.

Recommended prerequisites: (brief description of the knowledge required to follow this course - Maximum 2 lines).
In order to follow this course, basic knowledge of general drawing principles is required.

Content of the subject:

Chapter 1. General Information. **(2 weeks)**
1.1 Usefulness of technical drawings and different types of drawings.
1.2 Drawing materials.
1.3 Standardization (Types of lines, Writing, Scale, Drawing format and folding, Title block, etc.).

Chapter 2. Elements of descriptive geometry **(6 weeks)**
2.1 Notions of descriptive geometry.
2.2 Orthogonal projections of a point - Epure of a point - Orthogonal projections of a line (any and particular) - Epure of a line - Traces of a line - Projections of a plane (any and particular positions) - Traces of a plane.
2.3 Views: Choice and arrangement of views - Dimensioning - Slope and conicity - Determination of the 3rd view from two given views.
2.4 Method of execution of a drawing (layout, 45° line, etc.)
Application exercises and evaluation (PW)

Chapter 3. Perspectives **(2 weeks)**
Different types of perspectives (definition and purpose).
Application exercises and evaluation (PW).

Chapter 4. Sections and cuts **(2 weeks)**
4.1 Sections, standardized representation rules (hatching).
4.2 Projections and section of simple solids (Projections and sections of a cylinder, a prism, a pyramid, a cone, a sphere, etc.).
4.3 Half-cut, partial cuts, broken cuts, Sections, etc.
4.4 Technical vocabulary (terminology of machined shapes, profiles, piping, etc.)
Application exercises and evaluation (PW).

Chapter 5. Dimensioning **(2 weeks)**
5.1 General principles.
5.2 Dimensioning, tolerance, and adjustment.
Application exercises and evaluation (PW).

Chapter 6. Notions about definition and assembly drawings and nomenclature. **(1 week)**

Application exercises and evaluation (PW).

Assessment method: Continuous control: 100%.

Bibliographical Bibliographical references:::
(According to the avai(Lab)ility of documentation at the institution, websites, etc.)

1. Guide du dessinateur industriel Chevalier A. Edition Hachette Technique;
2. Le dessin technique 1er partie géométrie descriptive Felliachi d. et Bensaada s. Edition OPU Alger;
3. Le dessin technique 2er partie le dessin industriel Felliachi d. et bensaada s. Edition OPU Alger;
4. Premières notions de dessin technique Andre Ricordeau Edition Andre Casteilla;
5. **المدخل إلى الرسم الصناعي** ماجد عبد الحميد ديوان المطبوعات الجامعية الجزائر
6. **مبادئ أساسية في الرسم الصناعي** عمر أبو حنيك المعهد الجزائري للتقييس والملكية الصناعية طبع الحميد ديوان المطبوعات الجامعية الجزائر

Recommendation: A large part of the practical work should be done as personal work at home.

Semester: 3
Teaching Unit: MU 2.1
Subject 4: Waves and Vibrations (Lab)
TH/S: 15:00 ((Lab): 1:00)
Credits: 1
Coefficient: 1

Teaching objectives:
The objectives assigned by this program aim to initiate students in the practical application of their knowledge on mechanical vibrations phenomena restricted to low-amplitude oscillations for one or two degrees of freedom, as well as the propagation of mechanical waves.

Recommended prerequisites:
Vibrations and Waves, Mathematics 2, Physics 1, Physics 2.

Content of the subject::

PW 1: Mass-spring system
PW 2: Simple pendulum
PW 3: Torsion pendulum
PW 4: Electrical circuit oscillating in free and forced regimes
PW 5: Coupled pendulums
PW 6: Transverse oscillations in vibrating strings
PW 7: Hoffman's pulley
PW 8: Electromechanical systems (the electrodynamic loudspeaker)
PW 9: Pohl's pendulum
PW 10: Propagation of longitudinal waves in a fluid.

Note: It is recommended to choose at least 5 (Lab)s out of the 10 proposed.

Assessment method:
Continuous control: 100%.

Bibliographical Bibliographical references::
(According to the avai(Lab)ility of documentation at the institution, internet sites, etc.)

Semester: 3
Teaching unit: DU 2.1
Subject 1: Basic Technology
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
This course aims to provide students with knowledge about the processes of obtaining and manufacturing parts and techniques for their assembly.

Recommended prerequisites:

Content of the subject:
Chapter 1. Materials **(3 weeks)**
1.1 Metals and alloys and their designations
1.2 Plastics (polymers)
1.3 Composite materials
1.4 Other materials

Chapter 2. Processes for obtaining parts without material removal **(4 weeks)**
2.1 Molding, forging, stamping, rolling, drawing, extrusion, etc.
2.2 Cutting, bending and stamping, etc.
2.3 Sintering and powder metallurgy
2.4 Profiles and pipes (steel, aluminum);
- Workshop visits.

Chapter 3. Processes for obtaining parts by material removal **(4 weeks)**
Turning, milling, drilling; fitting, etc.

Workshop visits and demonstrations.
Chapter 4. Assembly techniques **(4 weeks)**

Bolting, riveting, welding, etc.
Assessment method: Final exam: 100%.

Bibliographical Bibliographical references:::

- Manuel de technologie mécanique, Guillaume SABATIER, et al Ed. Dunod.
- Memotech : productique matériaux et usinage BARLIER C. Ed. Casteilla
- Sciences industrielles MILLET N. ed. Casteilla
- Memotech : Technologies industrielles BAUR D. et al , Ed. Casteilla
- Métrologie dimensionnelle CHEVALIER A. Ed. Delagrave
- Perçage , fraisage JOLYS R et (LAB)ELL R. Ed. Delagrave
- Guide des fabrications mécaniques PADELLA P. Ed. Dunod
- Technologie : première partie, Bensaada S et FELIACHI d. Ed. OPU Alger
- تكنولوجيا عمليات التصنيع خرير ز و فواز د. ديوان المطبوعات الجامعية الجزائر

Semester: 3
Teaching Unit: DU 2.1
Subject: Metrology
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::
The aim of this course is to teach students the precision criteria for the manufacture and assembly of mechanical parts. Students will learn how to choose, in different situations, the methods and means of controlling and measuring the dimensions and manufacturing defects of mechanical parts.

Recommended prerequisites:
Trigonometry, optics, and other related subjects.

Content of the subject::
Chapter 1. General information on metrology **(2 weeks)**
1.1 Definition of different types of metrology (scientific, legal, industrial);
1.2 Metrological vocabulary and definition;
1.3 National and international metrology institutions.

Chapter 2. The International System of Units SI **(3 weeks)**
2.1 Basic quantities and units of measurement;
2.2 Supplementary quantities;
2.3 Derived quantities.

Chapter 3. Metrological characteristics of measuring devices **(6 weeks)**
3.1 Error and uncertainty (accuracy, precision, fidelity, repeatability, reproducibility of a measuring device);
3.2 Classification of measurement errors
3.2.1 Raw value;
3.2.2 Systematic error;
3.2.3 Corrected raw value.
3.3 Random errors
3.3.1 Random errors;
3.3.2 Parasitic errors;
3.3.3 Estimated systematic errors.
3.4 Confidence interval;
3.5 Technical uncertainty;
3.6 Total measurement uncertainty;
3.7 Complete measurement result;
3.8 Identification and interpretation of specifications on a drawing for inspection purposes;
3.9 Basic concepts of gauges, measuring tools and instruments.

Chapter 4. Measurement and control **(4 weeks)**
4.1 Direct measurement of length and angle (using ruler, caliper, micrometer and protractor);
4.2 Indirect measurement (using comparator, standard gauges);
4.3 Dimensional inspection (using gauges, jaws, etc.);
4.4 Measuring and inspection machines used in mechanical workshops (using pneumatic comparators, profile projectors and roughness testers).

Assessment method: Final exam: 100%.

Bibliographical Bibliographical references:::
(According to the avai(Lab)ility of documentation at the institution, internet sites, etc.)

- Manuel de technologie mécanique, Guillaume SABATIER, et al Ed. Dunod.
- Memotech : productique matériaux et usinage BARLIER C. Ed. Casteilla
- Sciences industrielles MILLET N. ed. Casteilla
- Memotech : Technologies industrielles BAUR D. et al , Ed. Casteilla
- Métrologie dimensionnelle CHEVALIER A. Ed. Delagrave
- Perçage , fraisage JOLYS R et (LAB)ELL R. Ed. Delagrave
- Guide des fabrications mécaniques PADELLA P. Ed. Dunod
- Technologie : première partie, Bensaada S et FELIACHI d. Ed. OPU Alger
- تكنولوجيا عمليات التصنيع خرير ز و فواز د. ديوان المطبوعات الجامعية الجزائر

Semester: 3
Teaching Unit: TU 2.1
Subject 1: Technical English
Total Hours: 22.5 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::
This course aims to enable students to have a level of language proficiency that allows them to use scientific documents and discuss their specialty and field with ease and clarity in English.

Recommended prerequisites::
English 1 and English 2

Content of the subject::

Oral comprehension and expression, vocabulary acquisition, grammar, etc.
Nouns and adjectives, comparatives, following and giving instructions, identifying things.
Use of numbers, symbols, equations.
Measurements: length, surface, volume, power, etc.
Describing scientific experiments.
Characteristics of scientific texts.
Assessment method: Final exam: 100%.

Bibliographical Bibliographical references:::
(According to the avai(Lab)ility of documentation at the institution, websites, etc.)

Semester: 4
Teaching unit: FU2.2.1
Subject 1: Thermodynamics 2
TH/S: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives::
Fix the general ideas of thermodynamics and highlight their usefulness in engineering sciences. The objective is to be able to analyze energy systems by using the prerequisites of the first year in order to show what must be implemented for the study of water vapor and to introduce the study of thermal and refrigeration machine cycles.

Recommended prerequisites:

Thermodynamics of S2, Basic mathematics.

Content of the subject:
Chapter 1. Reminders on the Basic Concepts of Thermodynamics 0**(1 week)**
Reminder of the three principles of thermodynamics.

Chapter 2. Thermodynamic Properties of Pure Substances 0**(2 weeks)**.
State diagrams (T-s diagram, p-h diagram, h-s diagram), Thermodynamic tables (Tables of properties at saturation, Tables of properties of superheated steam), Equations of state (Equation of state of an ideal gas, Developments virial, Van Der Waals Equation, Equations of state derived from Van Der Waals equation, Reduced Variables and Law of Corresponding States, Semi-Empirical Equations of State).

Chapter 3. Thermodynamics of Vapors and Humid Air 0**(2 weeks)**.
Thermodynamics of Vapors (Phase Change of a Pure Body, Calculation of State Variables, Vapor Title, Thermodynamic Diagrams and Tables), Humid Air (Characterization of Humid Air, Mollier Diagram, Elementary Air Operations humid).

Chapter 4. Gas Compression 0**(2 weeks)**.
Classification of Compression Machines, Isentropic Compression, Polytropic Compression, Piston Compressors, Rotary Positive Displacement Compressors (Definitions).

Chapter 5. Gas Expansion 0**(2 weeks)**.
Expansion Machines, Adiabatic Expansion, Non-Adiabatic Expansion, Work, Efficiency and Power Produced, Rotary Volumetric Compressors

Chapter 6. Motor Cycles 0**(3 weeks)**.
Carnot Cycle, Otto Cycle, Diesel Cycle, Brayton Cycle, Steam Turbines, Rankine Cycle (Reheat Cycle, Withdrawal Cycle, Cogeneration).

Chapter 7. Refrigeration Cycles 0**(3 weeks)**.
Gas refrigeration cycle, Single-stage vapor compression cycle, Refrigerants, Thermal load of a cold room, Two-stage compression cycles, Cascade cycles, Heat pumps

Bibliographical references:

1- Y. CENGEL, M. A. BOLES, 'Thermodynamique, une approche pragmatique', Edition of Boeck, the Chenceliere, 2008 . Tranlated for English by M. Lacroix 'Thermodynamics, an Engineering approach'.

2- Andre HOUBERECHTS « La thermodynamique technique », tomes 1 et 2

3- SONNTAG et VAN WYLEN, 'Thermodynamique et applications', traduit de l'anglais, Fundamentalsof classical thermodynamics' ed. Mc Graw Hill.

4- G. BRUHAT, Revue et augmenté par A. KASTLER, 'Thermodynamique', Edition 6, Masson &Cie.

5- R. Kling, 'Thermodynamique et applications', Technip Edition.

6- M. J. MORAN and HOWARD M. SHAPIRO, Fundamentales of engineering Thermodynamic', J. Wyley & sons editors, 2006.

7- RAPIN-JACQUARDInstallations frigorifiques (technologie), Dunod Edition; 2004

8- J. P. PEREZ 'Thermodynamique: Fondements et applications', Dunod, Paris 2001.

Semester: 4
Teaching unit: FU 2.2.1
Subject 1: Mechanical Manufacturing
TH/S: 22h30 (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::

To provide students with knowledge of manufacturing techniques for mechanical products in particular.

Recommended prerequisites::

Basic technology, materials science.

Content of the subject::

I- Metal Cutting Theory
1.1 Cutting materials (**(1 week)**)
1.2 Cutting tool geometry (**(1 week)**)
1.3 Chip formation mechanism (**(1 week)**)
1.4 Cutting forces (**(1 week)**)
1.5 Heating (Cutting temperature)
1.6 Cutting tool damage (**(1 week)**)
1.7 Methodology for choosing cutting parameters (**(1 week)**)

II- Machine Tool Technologies

2.1 Cutting movements (**(1 week)**)
2.2 Machine tool characterization (Main components) **((2 weeks))**
• Spindle
• Frame
• Slides
2.3 Kinematic chains **((6 weeks))**
• Mechanisms for transmitting movements
• Lathes, planers and shapers, drills, milling machines, broaching machines, cylindrical and flat grinding machines, etc...

Assessment method: Exam: 100%.

Bibliographical Bibliographical references:::
1- Techniques de l'ingénieur 2000 B.BM.BT. Janvier 2000 Printed in France by Imprimerie Strasbourgeoise Schiltighein- ISTRAIN
2- Roger Bonetto les ateliers flexibles de production 2ème édition Hermes 1987-Paris
3- G. Levallant ; M.Dessoly ; P.Géodossi ; P.Leroux ; J.C.Moulet ; G.Poulachon ; P.Robert Usinage par enlèvement de copeaux- de la technologie aux applications industrielles Ensam. Edition Eyrolles N° 7211- Juin 2005 Paris
4- Eléments de Fabrication Edition Ellipses. Copyright 1995 Paris
5- Michel Ahby, Choix de Matériaux en Conception Mécanique ; Dunod, 1999
6- Claude Hazard, La Commande Numérique des M O, édition Foucher, Paris 1984

7- Gonzalez, CN par calculateur, édition Foucher Paris 1985.
8- Philippe DEPEYRE, Cours « Fabrication mécanique », Faculté des Sciences et Technologies, Université de la Réunion, Année 2004-2005

Semester: 4
Teaching Unit: FU2.2.1
Subject 1: Mathematics 4
TH/S: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives::
This course focuses on the differential and integral calculus of complex functions of a complex variable. The student must master the different techniques for solving functions and integrals with complex and special variables.

Recommended prerequisites:
Mathematics 1, Mathematics 2, and Mathematics 3.

Content of the subject::
Complex variable functions and Special functions

Chapter 1. Holomorphic functions. Cauchy-Riemann conditions **((3 weeks))**

Chapter 2. Power series **((3 weeks))**
Convergence radius. Convergence domain. Development in power series. Analytic functions. Laurent series and development in Laurent series.

Chapter 3. Cauchy's theory **((3 weeks))**
Cauchy's theorem; Cauchy's formulas. Singular points of functions, general method for calculating complex integrals.

Chapter 4. Applications **((4 weeks))**
Equivalence between holomorphy and analyticity. Maximum theorem. Liouville's theorem. Rouché's theorem. Residue theorem. Calculation of integrals using the residue method.

Chapter 5. Special Functions **((2 weeks))**
Euler's special functions: Gamma and Beta functions, applications to integral calculus.

Assessment method:
Continuous control: 40%; Final exam: 60%.

Bibliographical Bibliographical references::
1- Henri Catan, Théorie élémentaire des fonctions analytiques d'une ou plusieurs variables complexes. Editeur Hermann, Paris 1985.
2- Jean Kuntzmann, Variable complexe. Hermann, Paris, 1967.Manuel de premier cycle.
3- Herbert Robbins Richard Courant. What is Mathematics ?, Oxford University Press, Toronto,1978. Ouvrage classique de vulgarisation.
4- Walter Rudin, Analyse réelle et complexe. Masson, Paris, 1975. Manuel de deuxième cycle.

Semester:4
Teaching unit: FU2.2.2
Subject : Numerical methods
TH/S: 45h00 (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives: :
Familiarization with numerical methods and their applications in the field of mathematical calculations.

Prior knowledge recommended :
Math1, Math2, Informatic 1 and Informatic 2

Content of the subject::

Chapter 1. Solving nonlinear equations f(x)=0 **(3 weeks)**

1. Introduction to calculation errors and approximations,
2. Introduction to methods for solving nonlinear equations,
3. Bisection method,,
4. Method of successive approximations (fixed point),
5. Method of Newton-Raphson.

Chapter 2. Polynomial Interpolation **(2 weeks)**

1. General introduction,
2. Lagrange polynomial,
3. Newton's polynomials.

Chapter 3 : Approximation of function: **(2 weeks)**

1. Approximation method and quadratic mean..
2. Orthogonal or pseudo-Orthogonal systems. Approximation by orthogonal polynomials
3. Trigonometric approximation

Chapter 4. Numerical Integration **(2 weeks)**

1. General introduction,
2. Trapeze method,,
3. Simpson's method,
4. Quadrature formulas..

Chapter 5. Solving Ordinary Differential Equations **(2 weeks)**
(problem of the initial condition or of Cauchy).

1. General introduction,
2. Euler method,
3. Improved Euler method,,
4. Runge-Kutta method..

Chapter 6. Direct method resolution of systems of linear equations **(2 weeks)**

1. Introduction and definitions,
2. Gauss method and pivoting,
3. LU factorization method,

4. Cholesky factorization method, MM^t,
5. Thomas algorithm (TDMA) for tri-diagonal systems.

Chapter 7. Approximate solving method for linear equations system **(2 weeks)**

1. Introduction and definitions,
2. Jacobi Method,
3. Gauss-Seidel Method,
4. Use of relaxation.

Assessment method:

Continuous control: 40%; Exam: 60%.

Bibliographical references:

1. BREZINSKI (C.), Introduction à la pratique du calcul numérique. Dunod, Paris (1988).
2. G. Allaire et S.M. Kaber, 2002. Algèbre linéaire numérique. Ellipses.
3. G. Allaire et S.M. Kaber, 2002. Introduction à Sci(Lab). Exercices pratiques corrigés d'algèbre linéaire. Ellipses.
4. G. Christol, A. Cot et C.-M. Marle, 1996. Calcul différentiel. Ellipses.
5. M. Crouzeix et A.-L. Mignot, 1983. Analyse numérique des équations différentielles. Masson.
6. S. De(Lab)rière et M. Postel, 2004. Méthodes d'approximation. Équations différentielles. Applications Sci(Lab). Ellipses.
7. J.-P. Demailly, 1996. Analyse numérique et équations différentielles. Presses Universitaires de Grenoble,1996.
8. E. Hairer, S. P. Norsett et G. Wanner, 1993. Solving Ordinary Differential Equations , Springer.
9. CIARLET (P.G.). Introduction à l'analyse numérique matricielle et à l'optimisation. Masson, Paris (1982).

Semester: 4
Teaching Unit: FU2.2.3
Subject 1: Strength of Materials
TH/S: 45h00 (Lecture: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:: To know the methods of calculating the resistance of construction elements and determine the variations in shape and dimensions (deformations) of elements under the action of loads.

Recommended prerequisites:: Function analysis; rational mechanics.

Content of the subject::

Chapter 1. INTRODUCTIONS AND GENERALITIES **((2 weeks))**
1.1 Goals and assumptions of strength of materials
1.2 Classification of solids (beam, plate, shell)
1.3 Different types of loads
1.4 Connections (supports, fixings, hinges)
1.5 General equilibrium principle - Equilibrium equations
1.6 Cutting principles - Reduction elements
1.7 Definitions and sign conventions of:

Normal force N,
Shear force T,
Bending moment M
Chapter 2. TENSION AND COMPRESSION **((3 weeks))**
2.1 Definitions
2.2 Normal stress of tension and compression
2.3 Elastic deformation in tension/compression
2.4 Condition of resistance to tension/compression

Chapter 3. SHEAR **((2 weeks))**
3.1 Definitions
3.2 Simple shear - pure shear
3.3 Shear stress
3.4 Elastic deformation in shear
3.5 Condition of resistance to shear

Chapter 4. GEOMETRIC CHARACTERISTICS **((3 weeks))**
OF STRAIGHT SECTIONS
4.1 Static moments of a straight section
4.2 Moments of inertia of a straight section
4.3 Formulas for transforming moments of inertia

Chapter 5. TORSION **((2 weeks))**
5.1 Definitions
5.2 Tangential stress or sliding stress
5.3 Elastic deformation in torsion
5.4 Condition of resistance to torsion

Chapter 6. SIMPLE PLANE BENDING **((3 weeks))**
6.1 Definitions and assumptions
6.2 Shear forces, bending moments
6.3 Shear force and bending moment diagrams
6.4 Relationship between bending moment and shear force
6.5 Deformation of a beam subjected to simple bending (deflection)
6.6 Stress calculation and sizing

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical references:

- Mécanique à l'usage des ingénieurs – statique. Ferdinand P. Beer et Russell Johnston, Jr.,McGraw-Hill, 1981.
- Résistance des matériaux, P. STEPINE, Editions MIR ; Moscou, 1986.
- Résistance des matériaux 1, William A. Nash, McGraw-Hill, 1974.
- Résistance des matériaux, S. Timoshenko, Dunod, 1986

Semester: 4
Teaching Unit: MU2.2
Subject 1: Computer-Aided Design
TH/S: 22h30 (PW : 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
This course will enable students to acquire the principles of representation of parts in industrial drawing. Furthermore, this subject will enable the student to represent and read plans.

Recommended prerequisites: Technical Drawing.

Content of the subject::

PRESENTATION OF CHOSEN SOFTWARE **((4 weeks))**
(SolidWorks, AutoCAD, Catia, Inventor, etc.)
1.1 Introduction and history of CAD;
1.2 Configuration of the chosen software (interface, shortcut bar, options, etc.);
1.3 Reference elements of the software (software aids, tutorials, etc.);
1.4 File saving (part file, assembly file, layout file, backup procedure for submission to the teacher);
1.5 Communication and interdependence between files.

SKETCH NOTIONS **((3 weeks))**
2.1 Sketch tools (point, line segment, arc, circle, ellipse, polygon, etc.);
2.2 Sketch relations (horizontal, vertical, equal, parallel, collinear, fixed, etc.);
2.3 Dimensioning sketches and geometric constraints.

3D MODELING **((3 weeks))**
3.1 Notions of planes (front plane, right plane, and top plane);
3.2 Basic functions (extrusion, removal of material, revolution);
3.4 Display functions (zoom, multiple views, multiple windows, etc.);
3.5 Modification tools (erase, offset, copy, mirror, adjust, extend, move);
3.6 Creation of a sectional view of the model.

LAYOUT OF THE 3D MODEL **((3 weeks))**
4.1 Layout and title block editing:
4.2 Choice of views and layout:
4.3 Dressings and object properties (hatching, dimensioning, text, tables, etc.).

ASSEMBLIES **((2 weeks))**
5.1 Assembly constraints (parallel, coincident, coaxial, fixed, etc.):
5.2 Creation of assembly drawings:
5.3 Layout of assembly and part nomenclature:

Exploded view.

Assessment method:
Continuous control: 100%.

Bibliographical references:

- Solidworks bible 2013 Matt Lombard, Edition Wiley,
- Dessin technique, Saint-Laurent, GIESECKE, Frederick E. Éditions du renouveau pédagogique Inc., 1982.
- Exercices de dessins de pièces et d'assemblages mécaniques avec le logiciel SolidWorks, Jean-Louis Berthéol, François Mendes,
- La CAO accessible à tous avec SolidWorks : de la création à la réalisation tome1 Pascal Rétif,
- Guide du dessinateur industriel, Chevalier A, Edition Hachette Technique,

Semester: 4
Teaching Unit: MU2.2
Subject 2: Fluid Mechanics (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
This course allows students to apply their knowledge in fluid mechanics taught in S3.

Recommended prerequisites::
Subjects: Fluid Mechanics and Physics 1.

Content of the subject::

Viscometer
Determination of linear and singular head losses
Flow rate measurement
Water hammer and mass oscillations
Verification of Bernoulli's theorem
Jet impact
Flow through an orifice
Visualization of flow around an obstacle
Determination of Reynolds number: Laminar and turbulent flow

Assessment method:
Continuous control: 100%.

Semester: 4
Teaching Unit: MU2.2
Subject: Numerical Methods (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
Programming of different numerical methods for their application in the field of mathematical calculations using a scientific programming language (Mat(Lab), Sci(Lab), etc.).

Recommended prerequisites:
Numerical methods, Computer Science 2 and Computer Science 3.

Content of the subject::

Nonlinear Equations Solving **((3 weeks))**
1.1. Bisection method
1.2. Fixed point method
1.3. Newton-Raphson method

Interpolation and Approximation **((3 weeks))**
2.1. Newton's interpolation
2.2. Tchebychev approximation

Numerical Integration **((3 weeks))**
3.1. Rectangle method
3.2. Trapezoidal method
3.3. Simpson's method

Differential Equations **((2 weeks))**
4.1. Euler's method
4.2. Runge-Kutta methods

Linear Equations Systems **((4 weeks))**
5.1. Gauss-Jordan method
5.2. Crout's decomposition and LU factorization
5.3. Jacobi's method
5.4. Gauss-Seidel method

Assessment method:
Continuous control: 100%

Bibliographical references:
1. Algorithmique et calcul numérique : travaux pratiques résolus et programmation avec les logiciels Sci(Lab) et Python / José Ouin, . - Paris : Ellipses, 2013 . - 189 p.
2. Mathématiques avec Sci(Lab) : guide de calcul programmation représentations graphiques ; conforme au nouveau programme MPSI / Bouchaib Radi, ; Abdelkhalak El Hami . - Paris : Ellipses, 2015 . - 180 p.

Méthodes numériques appliquées : pour le scientifique et l'ingénieur / Jean-Philippe Grivet, . - Paris : EDP sciences, 2009 . - 371 p

Semester: 4
Teaching Unit: MU 2.2
Subject: Material Resistance (Lab)
TH/S: 15:00 (PW : 1h00)
Credits: 1
Coefficient: 1

Teaching objectives::
To apply the different stresses studied in the material resistance module and to determine the characteristics of materials from simple mechanical tests.

Recommended prerequisites: Material resistance, material science.

Content of the subject::

PW No. 1: Tensile and compressive testing
PW No. 2: Torsion testing
PW No. 3: Bending testing
PW No. 4: Resilience testing
PW No. 5: Hardness testing

Assessment method:
Continuous control: 100%.

Semester: 4
Teaching Unit: MU2.2
Subject 5: Mechanical Manufacturing (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::
To apply different machining processes.

Recommended prerequisites::
Mechanical manufacturing course and technical drawing.

Content of the subject::

PW No. 1: Turning of a cylindrical part with 2 diameters with dressing and facing operations
Execution of rough and definition drawings.
Determination of cutting speeds and development of machining sequence for the part.
Preparation of tools, machine, and measuring instruments.
Positioning, clamping of the rough part, machine setting, and adjustment.
Execution of operations and the part.

PW No. 2: Milling and drilling of a prismatic part with mainly milling and drilling phases.
Definition of the shape, dimensions, tolerances, and surface conditions of the part (definition drawing).
Rough drawing.
Determination of cutting speeds and development of machining sequence for the part (without the grinding phase).
Cutting of the rough part.
Preparation of tools, machine(s), and measuring instruments.
Positioning, clamping of the rough part, machine setting, and adjustment.
Execution of operations and the part.

PW No. 3: Flat grinding and examination of surface conditions (using the part from PW No. 2).
Analysis of the rough and definition drawings from PW No. 2.
Determination of grinding speeds and development of complete machining sequence for the part (including the grinding phase).
Preparation of tools, machine, and measuring instruments for surface condition (roughness).
Positioning, clamping of the rough part, machine setting, and adjustment.
Execution of the grinding phase and checking of the surface condition.

PW No. 4: Welding
Preparation of parts to be assembled.
Choice of filler metal.
Execution of the weld bead.
Cleaning and inspection.

Assessment mode:
Continuous control: 100%.

Semester : 4
Teaching unit: DU2.2
Subject 1: Industrial electricity
TH/S: 22h30 (Class: 1h30)
Credits:1
Coefficient: 1

Teaching objectives: : The objective of the program is to submit to students of Mechanical Engineering, a set of essential and necessary knowledge for the physical understanding of the essence of electro-technical phenomena.

Recommended prerequisites: : The basic teachings of physical sciences acquired in the common core of science and technology.

Matter content :

Chapter 1 – Electrical Circuits **((4 weeks))**
- 1.1 Introduction
- 1.2 Current and voltage in electrical circuits
- 1.3 Resistance and equivalent circuit
- 1.4 Work and power
- 1.5 Monophasic and triphasic electric circuits

Chaptre 2 – Magnetic circuits **((3 weeks))**
- 2.1 Magnetism and Electricity
- 2.2 Basic Laws
- 2.3 Materials and magnetic circuits

Chaptre 3 – Transformers **((2 weeks))**
- 3.1 Description
- 3.2 Equivalent circuits
- 3.3 Measurement Transformers
- 3.4 Special Transformers

Chaptre 4 – Electrical Machines **((3 weeks))**
- 4.1 DC machines (shunt excitation, separate, series)
- 4.2 synchronous machines
- 4.3 Asynchronous machines
- 4.4 Special machines
- 4.5 Connecting of three-phase motors

Chaptre 5 – Electrical Measurements **((3 weeks))**
- 5.1 Measurement in physics
- 5.2 The quality of measurement – errors
- 5.3 Structure of digital display appareil
- 5.4 Current and voltage measurements
- 5.5 Power and energy measurements
- 5.6 Wiring diagrams of an electrical installation - wire section Calculation

Evaluation mode :
Exam: 100%.

Bibliographical references:

- Exercices et problèmes d'électrotechniques notions de base, réseaux et machines électriques ; Luc Lasne ; édition Dunod 2011.
- Electrotechnique : modélisation et simulation des machines électriques ; Rachid Abdessemed ; édition Ellipse 2011.
- Circuits électriques : régime continu, sinusoïdal et impulsionnel, Jean-Paul Bancarel , édition Ellipse 2001.
- Analyse des circuits électriques, Charle K. Alexander et Matthew Sadiku ; édition de boeck. 2012.

Semester: 4
Teaching unit: DU2.2
Subject 2: Materials Science
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::
This subject allows the student to understand the classification of materials as well as the basic concepts of crystallography, equilibrium diagrams, and heat treatments.

Recommended prerequisites::
Fundamental subjects from S1 and S2.

Content of the subject::

Chapter 1. Generalities (0**(3 weeks)**)
1.1 Classification of materials:
1.1.1 Metals and alloys
1.1.2 Ceramics and glasses
1.1.3 Polymers
1.1.4 Composite materials
1.2 Fields of application
1.3 Material structure: amorphous and crystalline materials
1.4 Crystallography concepts

Chapter 2. Equilibrium diagrams (0**(4 weeks)**)
2.1 Material crystallization
2.1.1 Crystallization principle and cooling curves
2.1.2 Crystallization of a pure metal
2.1.3 Crystallization of an alloy
2.2 Equilibrium diagram of two completely miscible metals
2.3 Equilibrium diagram of two partially miscible metals

Chapter 3. Iron-carbon equilibrium diagram (0**(4 weeks)**)
3.1 Characteristics of iron and carbon
3.2 Iron-carbon equilibrium diagram
3.3 Iron-cementite equilibrium diagram
3.4 Standard designation of steels and cast irons
3.5 Standard designation of other alloy steels

Chapter 4. Heat treatment and thermochemical diffusion treatment (0**(3 weeks)**)

Heat treatments
Annealing
Quenching
Tempering
Thermochemical treatments
Carburizing
Nitriding
Carbonitriding

Assessment mode:

Exam: 100%.

Bibliographical references:

- Science et génie des matériaux ; De William D. Callister.Dunod.
- Matériaux. T1 Propriétés, applications et conception, Michael F. Ashby, David R. H. Jones Collection: Sciences Sup, Dunod
- Matériaux. T2 Microstructures, mise en œuvre et conception ; Michael F. Ashby, David R. H. Jones Collection: Sciences Sup, Dunod
- Des matériaux, Jean-Marie Dorlot, Jean-Paul Baïlon. Presses internationales Polytechnique.
- Structures et matériaux : L'explication mécanique des formes, James Gordon

Semester: 4
Teaching Unit: TU2.2
Subject: Techniques of Expression, Information, and Communication
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::

This course aims to develop the student's personal or professional skills in the field of communication and expression techniques. It also enables the student to learn about the techniques, tools, and methods used to facilitate communication.

Recommended prerequisites::
Languages (Arabic; French; English)

Content of the subject::

Chapter 1. Research, analyze and organize information **((2 weeks))**
Identifying and using places, tools, and documentary resources; understanding and analyzing documents; constructing and updating documentation.

Chapter 2. Improve expression capacity **((2 weeks))**
Taking into account the communication situation, producing a written message, communicating orally, producing a visual and audiovisual message, improving group communication capacity.

Chapter 3. Develop autonomy, organizational and communication skills in a project approach **((2 weeks))**
Positioning oneself in a project and communication approach, anticipating action, implementing a project: presentation of a practical work report (homework assignment).

Chapter 4. ICT - Definition and Evolution **((2 weeks))**
Definition; activities using ICT; mastering ICT skills; evolution of ICT; information and communication services.

Chapter 5. Information search, use, and retrieval **((2 weeks))**
Search directories (YAHOO, GOOGLE), search engines, query language and search, retrieval and printing of an HTML page, retrieval of an image, download of a file or software, reading an HTML file locally, reading a multimedia file saved on the Web.

Chapter 6. ICT Rights **((2 weeks))**
Computer crime, media law, electronic communications law, electronic commerce law, Internet governance, etc.

Chapter 7. Securing sensitive information, protecting confidential data, and preserving nuisances **((3 weeks))**
Backing up important data, "Informatique et libertés" law, Internet dangers, computer hacking, machine protection, protection against viruses, protection against cyber threats or online threats (Phishing, spam emails, spyware, malware, ransomware, viruses and trojan horses, man-in-the-middle attacks, etc.), preventing data loss, spam emails, hoaxes, cryptography, electronic signature, etc.

Assessment method:
Final exam: 100%.

Bibliographical Bibliographical references:::
(Books and course materials, websites, etc.)

1. Jean-Denis Commeignes, 12 méthodes de communications écrites et orale – 4éme édition, Michelle Fayet et Dunod 2013.
2. Denis Baril, Sirey, Techniques de l'expression écrite et orale, 2008.
3. 3- Matthieu Dubost, Améliorer son expression écrite et orale toutes les clés, Edition Ellipses 2014.
4. Allegrezza Serge et Dubrocard Anne (edited by). Internet Econometrics. Palgrave Macmillan Ltd, 2011. ISBN-10: 0230362923 ; ISBN-13: 9780230362925
5. Anduiza Eva, Jensen J. Michael et JorbaLaja (edited by). Digital Media and Political Engagement Worldwide. Cambridge UniversityPress - M.U.A, 2012. ISBN-10: 1107668492 ; ISBN-13: 9781107668492
6. Baron G.L., et Bruillard E. L'informatique et ses usagers dans l'éducation. Paris, PUF, 1996. ISBN-10: 2130474926; ISBN-13: 978-2130474920
7. En ligneChantepie P. et Le Diberder A. Révolution numérique et industries culturelles. Repères. Paris, La Découverte, 2010. ISBN-10: 2707165050; ISBN-13: 978-2707165053
8. Dawn Medlin B. Integrations of Technology Utilization and Social Dynamics in Organizations. Information Science Reference (Isr), 2012. ISBN-10: 1-4666-1948-1; ISBN-13: 978-1-4666-1948-7
9. Devauchelle B. Comment le numérique transforme les lieux de savoirs. FYP Editions, 2012. ISBN-10: 2916571612; ISBN-13: 978-2916571614
10. Greenfield David. « The Addictive Properties of Internet Usage ». In Internet Addiction, 133?153. John Wiley & Sons, Inc., 2007. ISBN: 9780470551165. htPW://dx.doi.org/10.1002/9781118013991.ch8.
11. Kurihara Yutaka et [Al.]. Information technology and economic development. Information Science Reference (Isr), 2007. ISBN 10: 1599045818 ; ISBN 13: 9781599045818
12. Paquelin D. L'appropriation des dispositifs numériques de formation. Du prescrit aux usages. Paris, L'Harmattan, 2009. ISBN-10: 2296085563 ; ISBN-13: 978-2296085565
13. Tansey Stephen D. Business, information technology and society. Routledge Ltd, 2002. ISBN-10: 0415192137 ; ISBN-13: 978-0415192132

Semester: 5
Teaching Unit: FU 3.1.1
Subject 1: Fluid Mechanics 2
TH/S: 67h30 (Class: 3h00; Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives::
This subject is a continuation of Fluid Mechanics 1, focusing on fluid kinematics, analysis based on the concept of control volume, and dimensional analysis and similarity.

Recommended prerequisites::
Fluid Mechanics 1, Thermodynamics, Physics 1 and 2.

Content of the subject::
Chapter 1. Fluid Kinematics **((6 weeks))**
Reference systems. Continuity equation: differential form. Notions of volumetric flow rate and mass flow rate. Rotational and irrotational flows. Circulation and vorticity.
Irrotational or potential velocity flows. Planar flows. Elementary potential flows. Superposition of simple flows. Graphical superposition method. Elements of complex potential theory. Elementary potential flows expressed in complex form. Method of conformal transformations.

Chapter 2. Analysis based on the concept of control volume **((5 weeks))**
2.1 Conservation of mass - continuity equation. Derivation of the continuity equation. Fixed, non-deformable control volume. Control volume that is non-deformable but in motion. Deformable control volume.
2.2 Newton's second law - linear equations of momentum and moment of momentum. Derivation of the linear momentum equation. Application of the linear momentum equation. Derivation of the linear moment of momentum equation. Application of the linear moment of momentum equation.

Chapter 3. Dimensional analysis and similarity **((4 weeks))**
Introduction. Dimensional analysis. Similarity. Applications.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:::

1. R. Comolet, « Mécanique expérimentale des fluides », Editeur Masson, 1976, Tomes I, II et III.
2. R. B. Bird, W. E. Stewart, E. N. Lightfoot, "Transport Phenomena", Wiley editor, 1960.
3. Rjucsh K. Kundu, I. M. Cohen, "Fluid Mechanics", 2nd Edition, Academic Press, 2002.
4. D. P. Kesseler and R. A. Greenkorn, "Momentum, Heat, and Mass transfer: Fundamentals", M. Dekker, 1999.
5. T. C. Papanastasiou, G. C. Georgiou and A. N. Alexandrou, "Viscous fluid flow", CRC Press LLC, 2000.
6. G. Emanuel, "Analytical Fluid, Dynamics", 2nd edition, CRC Press, 2000.
7. R. W. Fox, A. T. Mc Donald and P. J. Pritchard, "Introduction to fluid mechanics", sixth edition, Wiley and sons editor, 2003.
8. G. K. Batchelor, FRS, "An Introduction to fluid dynamics", Cambridge University Press.
9. Fundamentals of fluidmechanics 6thedition Munsen, Young, Okiishi, Huebsch. John Wiley& Sons, Inc. 2009.
10. Fluid Mechanics, Frank M. White University of Rhode IslandSeventh Edition Published by MC Graw-hill 2011.

Semester: 5
Teaching Unit: FU 3.1.1
Subject 2: Heat Transfer 1
TH/S: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives::

Appreciate the heat conductive powers of common materials, evaluate the rates of heat transfer by conduction in steady state for common geometries. Applications for rectangular fins. Know the mechanisms of heat transfer between a fluid and a solid surface.

Prior knowledge recommended:

Thermodynamics, Fluid mechanics, Mathematics.

Content of the subject::

Chapter 1. Introduction of heat transfers and position with regard to the thermodynamics. ((1 week))

Chapter 2. Basic Heat Transfer Laws ((2 weeks))

Chapter 3. Heat Conduction ((7 weeks))

Fourier's law. Thermal conductivity and orders of magnitude for common materials. Discussion of the parameters on which thermal conductivity depends. Energy equation, simplifying assumptions and different forms. Spatial and initial boundary conditions. The four linear conditions and their practical meaning. Under what conditions can they be produced? Some solutions of the heat equation, in Cartesian, cylindrical and spherical coordinates with linear conditions. Case of conductive systems with heat sources. The stationary electrical analogy. The problem of the longitudinal rectangular fin: Equation of the fin. Resolution. Calculation of the performance and efficiency of the fin. Generalization of the fin concept. Application to the radial fin of uniform profile.

Chapter 4. Heat Transfer by convection ((5 weeks))

Mechanisms of heat transfer by convection. Parameters involved in convective transfers. Highlighting the different types of transfer by convection: Forced, natural and mixed convection. Give common examples. Discern between laminar and turbulent convective transfer in both forced and natural modes. Methods for solving a convection problem (Dimensional analysis and experiments, integral methods for approximate equations for boundary layer, solving equations representing convection and analogy with similar phenomena such as mass transfers). Dimensional analysis combined with experiments: Theorem Pi, showing the most used dimensionless numbers in forced and natural convection (Reynolds, Prandtl, Grashoff, Rayleigh, Peclet and Nusselt). Explain the meaning of these numbers..

Assessment method:

Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:::

1. J. F. Sacadura coordonnateur, « Transfert thermiques : Initiation et approfondissement », Lavoisier 2015.

2. Kreith, F.; Boehm, R.F.; et. al., "Heat and Mass Transfer", Mechanical Engineering Handbook Ed. Frank Kreith, CRC Press LLC, 1999.
3. Bejan and A. Kraus, "Heat Handbook", J. Wiley and sons 2003.
4. F. Kreith and M. S. Bohn. "Principles of Heat Transfer", 6th ed. Pacific Grove, CA: Brooks/Cole, 2001.
5. Y. A. Cengel, "Heat and Mass Transfer", Mc Graw Hill.
6. H. D. Baehr and K. Stephan, "Heat and Mass transfer", 2nd revised edition, Springer Verlag editor, 2006.
7. J. L. Battaglia, A. Kuzik et J. R. Puiggali, « Introduction aux transferts thermiques », Dunod 2010.
8. De Giovanni B. Bedat, « Transfert de chaleur », Cépaduès, 2012.
9. J. P. Holman, "Heat Transfer". 9th ed. New York: McGraw-Hill, 2002.
10. F. P. Incropera and D. P. DeWitt. "Introduction to Heat Transfer", 4th ed. New York: John Wiley & Sons, 2002.
11. J. Taine, J. P. Petit, « Transfert de chaleur et mécanique des fluides anisothermes », Dunod, 1988.
12. N. V. Suryanaraya. "Engineering Heat Transfer", St. Paul, Minn.: West, 1995.
13. H. D. Baehr and K. Stephan, "Heat and Mass transfer", 2nd revised edition, Springer Verlag.

Semester: 5
Teaching unit: FU 3.1.2
Subject 1: Turbomachinery 1
Total hours: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives::
Apply fluid mechanics to technical systems such as hydraulic pumps and turbines. Know how to design and install pumps. Understand the causes of pump failure. Calculate, select and install different types of hydraulic turbines according to demand.

Recommended prerequisites::
MDF1, Thermodynamics.

Content of the subject::
Chapter 1. Definitions and general theory of turbomachinery **((4 weeks))**
Classification of turbomachinery, general theory, Euler's theorem. Velocity diagram. Head, power. Efficiency of turbomachinery. Energy transferred component. Reaction degree, load variation, reaction degree.

Chapter 2. Pumps **((3 weeks))**
General relationships, centrifugal pumps and axial pumps, descriptions, velocity triangles, efficiencies.

Chapter 3. Similarities in turbomachinery **((3 weeks))**
General relationships, Rateau's invariants, other coefficients, similar machines in operation, generalization, specific speed.

Chapter 4. Cavitation in pumps **((2 weeks))**
Origin and criteria of cavitation, manifestation, influence of different factors, cavitation similarity.

Chapter 5. Hydraulic turbines **((3 weeks))**
The Pelton turbine, the reaction turbine, the Francis turbine, the Kaplan turbine.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical references:

1. P. HENRY, « Turbomachines hydrauliques », Presses Polytechniques et Universitaires Romandes, 1992.
2. M. Sedille, « Turbomachines Hydrauliques et thermiques », Masson, 1970.
3. P. Henry, « Turbomachines hydrauliques », 1992.
4. Peng, "Fundamentals of Turbomachinery", Wiley and Sons, 2008.
5. M. Pluviose, « Ingénierie des turbomachines**,** Circuits, vibrations, effets instationnaires et des exercices résolus », génie énergétique, Ellipses 2003.
6. P. Chambadal, « La turbine à gaz », 1997.
7. R. Bidard et J. Bonnin, « Energétique et turbomachines »**,** Eyrolles 1979.
8. L. Vivier, Turbines à vapeur et à gaz, 1965
9. M. Pluviose, « Conversion d'énergie par Turbomachines », 2009
10. J. Krysinski, « Turbomachines, théorie générale », OPU, Alger, 1986.
11. R. Bidard, J. Bonnin, « Energétique et Turbomachines », Eyrolles, Paris 1979.

A. Jaumotte, « Turbopompes centrifuges », P.U. Bruxelles, 1979.
12. Jaumotte, « Turbomachines : ventilateurs, souflantes et compresseurs centrifuges », P.U. de Bruxelles, 1979.
13. Adam Troskolanski, « Les Turbopompes (Théorie Tracé et Construction) », Eyrolles 1977.

Semester: 5
Teaching Unit: FU 3.1.2
Subject: Energy Conversion
TH/S: 45 hours (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives::

Apply the thermodynamics concepts acquired in previous years to various energy-producing or energy-consuming machines. Use exergy analysis to identify opportunities for improvement or failures in real thermodynamic systems. Conduct energy analysis of systems implementing combustion

Recommended prerequisites:

Thermodynamics

Content of the subject::

Chapter 1. Single-phase power cycles: ((4 weeks))

Definitions. Carnot cycle. Otto cycle. Diesel cycle. Mixed cycle. Joule-Brayton cycle. Ericsson cycle. Stirling cycle. Preheating or regenerative cycle. Multi-stage cycle with regenerator, cooling and intermediate heating. Different components of a gas power plant.

Chapitre 2 : Les cycles de puissance à deux phases:(4 semaines)

Rappels sur le changement de phase. Cycle de Rankine. Cycle de Hirn. Cycle à resurchauffe. Cycle à un ou plusieurs soutirages de vapeur. Cycle mixte (gaz-capeur). Centrales thermiques à vapeur. Installations hybrides (solaire-gaz). Installations à cogénération. Notion sur les centrales nucléaires.

Chapter 2. Two-phase power cycles: ((4 weeks))

Review of phase change. Rankine cycle. Hirn cycle. Reheat cycle. Cycle with one or more steam extractions. Mixed cycle (gas-turbine). Steam power plants. Hybrid installations (solar-gas). Cogeneration installations. Introduction to nuclear power plants.

Chapter 3. Exergy and exergetic analysis of thermodynamic systems ((3 weeks))
Application to gas power plants and steam power plants.

Chapter 4. Combustion Thermodynamics ((3 weeks))

Properties of mixtures, stoichiometric combustion, heat of formation and calorific values, adiabatic flame temperature. Chemical kinetics: Elementary reactions, chain reactions and production of free radicals, recombination reactions, equilibrium constants, reaction rates. Simplified combustion models, pressure dependence, partial equilibrium and quasi-steady

states. Autoignition and spontaneous ignition, effect of pressure on autoignition temperature, controlled ignition, critical heat flux for ignition

Assessment method:

Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references::

1. R. E. Sonntag and J. G. Van Wylen*, Fundamentals of classical thermodynamics*, Ed. J. Wiley & Sons, 1978
2. Kaster, *Thermodynamique 6ème édition,* Masson 1968
3. R. kling, *Thermodynamique et application*, Edition Technip.
4. M. Bertin, J. P. Faroux et J. Renault, *Thermodynamique,* Dunod Université, 1981.
5. M. W. Zemansky and R.H. Ditmann, *Heat and Thermodynamic*; 7th edition, McGraw Hill1981.
6. J. P. Perez, Thermodynamique, *Fondements et applications, seconde édition*, Masson 1997.
7. S. McAllister, Jyh-Yuan Chen and A. Carlos Fernandez-Pello, *Fundamentals of Combustion Processes,* Springer editor, 2011.
8. T. Poinsot and D. Veynante, *Theoretical and Numerical Combustion,* Edwards editor, 2005

Semester: 5
Teaching unit: MU 3.1
Subject: Heat Transfer (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
To practically illustrate the knowledge acquired in the heat transfer course.

Recommended prerequisites:
Heat transfer, thermodynamics.

Content of the subject::
Planning of some experiments related to heat transfer according to avai(Lab)le means.

Assessment method:
Continuous control: 100%.

Semester: 5
Teaching unit: MU 3.1
Subject 2: Turbomachines 1 (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
To practically illustrate the behavior of hydraulic turbomachines, hydraulic pumps, and turbines.

Recommended prerequisites::
Turbomachines.

Content of the subject::
Planning of some experiments related to turbomachines according to the avai(Lab)le means.

Assessment method:
Continuous control: 100%.

Semester: 5
Teaching Unit: MU 3.1
Subject 3: Energy Conversion (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
To apply the principles of energy conversion on energy machines practically.

Recommended prerequisites:
Energy Conversion.

Content of the subject::
Plan some experiments related to energy conversion based on the avai(Lab)le resources.

Assessment method:
Continuous control: 100%.

Semester: 5
Teaching unit: MU 3.1
Subject 4: Measurement and instrumentation
TH/S: 37h30 (Class: 1h30; PW: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives::
Acquire different experimental and measurement techniques, particularly those used in energy studies. Learn how to select appropriate instruments and sensors to conduct experiments, and be able to appreciate measurement errors.

Recommended prerequisites:
Thermodynamics, MDF, heat transfer, electricity...

Content of the subject::
Chapter 1. Measurement of thickness and length **((5 weeks))**
Mechanical instruments, pneumatic instruments, optical instruments, estimation of errors.

Chapter 2. Temperature measurements **((5 weeks))**
Thermocouples, thermistors, infrared detectors, pyrometers. Calibration of thermal sensors, errors related to thermal sensors, sensor selection, automatic measurement acquisition, and acquisition cards.

Chapter 3. Flow rate, velocity, and pressure measurements **((5 weeks))**
Different flowmeters, errors associated with each type and selection, Pitot, Präsil, and Prandtl tubes, hot-wire and hot-film anemometers, laser Doppler anemometers, PIV. Pressure measurements: mechanical sensors, piezoelectric sensors, electrical measurements, signal processing, interpretation of results, experiment design.

Practical work:
Depending on the institution's resources and avai(Lab)ility of equipment, at least five (05) practical works must be carried out in this subject.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:::
1. R.J. Goldstein, “Fluid Mechanics Measurements”, 1983.
2. J.O. Hinze, “Turbulence”, Mc Graw-Hill Book Cie, Inc, 1975.
3. C.G. Lomas, “Fundamentals of hot wire anemometry”, Cambridge Univ. Press. 1986.
4. E. Guyon, J.P. Hulin et L. Petit, « Hydrodynamique physique », CNRS Ed. 2001.

Semester: 5
Teaching Unit: DU 3.1
Subject 1: Introduction to machine elements
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::

To provide students a scientific and technological training in the field of mechanical engineering through knowledge of the elements and parts of standard machines, used in the construction of mechanical structures, their standardization as well as the mechanical power transmission.

Recommended prerequisites::

Industrial Design, Strength of Materials, Mechanical Manufacturing

Content of the subject::

Chapter 1. Introduction **((2 weeks))**

General information (Mechanical construction, Design engineering, Safety coefficient, Standards, Economy, Reliability)

Chapter 2. Threaded assemblies **((3 weeks))**

Screws, Bolts, studs fasteners, strength calculation (Shearing, Brinelling, bending, tightening a hyperstatic system, etc.

Chapter 3. Gears **((3 weeks))**

Spur Gear, Helical Gear, Bevel Gear, Worm gear

Chapter 4. Shafts and Axes **((2 weeks))**

Shafts and axes diameter calculation, verification of shafts and axes to fatigue.

Chapter 5. Transmission of motion (calculation and dimensioning) **((3 weeks))**

Sliding and thrust bearings, Rolling-Element bearings, Friction wheels, Belts, Chains…

Chapter 6. Couplings, Clutches and Brakes **((2 weeks))**

Assessment method: Exam: 100%.

Bibliographical Bibliographical references:::

1. B. J. Morvan, « Les engrenages », Ed. : Delcourt G. Productions, 01/2004.
2. G. Henriot, "Les engrenages", Ed. : Dunod
3. A. Pouget , T. Berthomieu , Y. Boutron, E. Cuenot, « Structures et mécanismes - Activités de construction mécanique », Ed. Hachette Technique.
4. R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu. « Précis de Construction Mécanique », Tome 1, Projets-études, composants, normalisation, AFNOR, NATHAN, 2001.
5. R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu, « Précis de Construction Mécanique », Tome 3, Projets-calculs, dimensionnement, normalisation, AFNOR, NATHAN, 1997.
6. Y. Xiong, Y. Qian, Z. Xiong, D. Picard, « Formulaire de mécanique », Pièces de construction, EYROLLES, 2007.
7. J. L. FANCHON, « Guide de Mécanique », NATHAN, 2008.
8. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 1, Principes et Eco-conception, DUNOD, 2009.

9. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 2, Applications, DUNOD, 2001.
10. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 3, Transmission de puissance par liens flexibles, DUNOD, 1999.
11. Bawin, V. et Delforge, C., « Construction mécanique », Edition originale : G. Thome, Liège, 1986.
12. M. Szwarcman, « Eléments de machines », édition Lavoisier, 1983.
13. W. L. Cleghorn, "Mechanics of machines", Oxford University Press, 2008.

Semester: 5
Teaching unit: DU 3.1
Subject 2: Control and Servomechanisms
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::
Recognize the main techniques for controlling mechanical systems and the components involved.

Recommended prerequisites:
Mathematics, numerical methods.

Content of the subject::
Chapter 1. Terminology of control systems (**(1 week)**)
Functional diagram of a servomechanism, Constituent elements of a functional diagram of a servomechanism.

Chapter 2. Laplace Transformation **((2 weeks))**
Definitions and properties.

Chapter 3. Transfer Functions **((2 weeks))**
Algebra of functional diagrams and transfer function of systems.

Chapter 4. Study of a First-Order Servomechanism **((3 weeks))**
Definition and transfer function, System response to different input signals.

Chapter 5. Study of a Second-Order Servomechanism **((3 weeks))**
Definition and transfer function, System response to different input signals, Representation of the system in the complex plane.

Chapter 6. BODE and Nyquist diagrams of servomechanisms **((2 weeks))**

Chapter 7. Stability study of servomechanisms **((2 weeks))**
Analytical stability criteria according to Routh and Hurwitz, Geometric criterion according to Nyquist.

Assessment method:
Exam: 100%.

Bibliographical Bibliographical references:::
1- H. Bourles, « Systèmes linéaires de la modélisation à la commande », Lavoisier, 2006, Paris.
2- J. M. Flans, « La régulation industrielle », Hermès, 1994, Paris.
3- P. de Larminat, « Automatique commande des systèmes linéaires », Hermès, 1996, Paris.
4- E. Godoy, « Régulation industrielle Collection: Technique et Ingénierie », Dunod, L'Usine Nouvelle, 2007.
5- J-M. Flaus, « La régulation industrielle: Régulateurs PID, prédictifs et flous », Hermes Sciences, 1994.

Semester: 5
Teaching Unit: TU 3.1
Subject 1: Environment and Sustainable Development
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::
To sensitize students to the relationship between energy, environment and sustainable development, and to master sources of pollution in order to ensure sustainable development.

Recommended prerequisites:
Fluid mechanics, fundamental thermodynamics, heat transfer, and environmental characteristics.

Content of the subject::

Chapter 1. Introduction to the concept of the environment **((2 weeks))**
Definition of the environment, General definition, Legal definition, Brief history, Man and the environment, How man has modified his environment, Demography as a scapegoat.

Chapter 2. The concept of sustainable development **((2 weeks))**
Definition, Brief history, The fundamental principles of sustainable development, The ethical principle, The precautionary principle, The prevention principle, The objectives of sustainable development, The environmental challenges of sustainable development.

Chapter 3. Environment and natural resources **((4 weeks))**
Introduction, Resources, Water, Air, Fossil fuels (oil, natural gas, coal, etc.), Other energies (solar, wind, hydraulic, geothermal, biomass, etc.), Mineral elements, Biodiversity, Soils, Food resources.

Chapter 4. Substances **((4 weeks))**
Different types of pollutants, Regulated pollutants, Organic compounds, Heavy metals, Particles, Chlorofluorocarbons, Effects of different substances on the environment, Greenhouse effect and climate change, Destruction of the ozone layer, Acidification, eutrophication, and photochemistry, Acid rain. Ozone peaks; Effects on materials; Effects on ecosystems: forest, freshwater reserve, Effects on health. Different types of emitters, Corinair nomenclature.

Chapter 5. Preservation of the environment **((3 weeks))**
Introduction of new materials, Reservation of oil for noble uses, Improvement of energy efficiency, Recycling, Economic, legal, and regulatory mechanisms for environmental preservation, The role of public authorities in solving environmental problems, The option of private solutions, Current environmental policies, The polluter-pays principle, Ecological taxation: eco-taxes, Tradable emission permits market.

Assessment method:
Exam: 100%.

Bibliographical Bibliographical references::
1- De Jouvenel, B., « Le thème de l'environnement, Analyse et prévision », 10, pp. 517533, 1970.
2- Faucheux S., Noël J-F, « Economie des ressources naturelles et de l'environnement » , Armand Collin, Paris.
3- Reed D. (Ed.), « Ajustement structurel, environnement et développement durable », l'Harmattan, Paris, 1995.

4- Vivien F-.D, « Histoire d'un mot, histoire d'une idée : le développement durable à l'épreuve du temps », Ed. scientifiques et médicales Elsevier ASA, pp. 19-60, 2001.
5- Boutaud, Aurélien, Gondran, Natasha, « L'empreinte écologique », Paris : La Découverte, 2009.
6- Lazzeri, Yvette (Dir.), « préface de Gérard Guillaumin, Développement durable, entreprises et territoires: vers un renouveau des pratiques et des outils », Paris, L'Harmattan, 2008.

Semester: 6
Teaching unit: FU 3.2.1
Subject 1: Turbomachinery 2
TH/S: 67h30 (Class: 3h00; Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
Apply the laws of fluid mechanics and thermodynamics to machines that produce and consume mechanical energy using compressible fluids. Understand the problems related to these types of machines during their operation.

Recommended prerequisites:
Thermodynamics and fluid mechanics.

Content of the subject:
Chapter 1. Presentation of an axial turbine (**(1 week)**)
Notions of aerodynamics of lifting profiles, lift and drag, angle of losses.

Chapter 2. Static and total thermodynamic quantities (**(1 week)**)
Definition of the total state and graphical representation on the (h,s) diagram.

Chapter 3. General equations of turbomachinery **((3 weeks))**
Conservation of total enthalpy in fixed channels, conservation of rothalpy in moving channels.

Chapter 4. Study of nozzles (simple nozzle and Laval nozzle) **((3 weeks))**
Different operating regimes (subsonic, sonic, supersonic), sonic blockage, shock waves at the front.

Chapter 5. Theory of single-cell action turbine (**(1 week)**)
Principle and definition, expressions of mass work, velocity triangle, role of fixed and moving channels, thermodynamic representation of actual operation on the (h,s) diagram, losses in the stator, losses in the rotor, losses due to remaining velocity, notion of avai(Lab)le head, aerodynamic efficiency.

Chapter 6. Study of the Curtis wheel. Multicellular turbines-Reaction turbines (**(1 week)**)
Principle and definition, representation of actual operation on the (h,s) diagram, aerodynamic efficiency.

Chapter 7. Compressors **((3 weeks))**
Velocity triangle, Thermodynamic evolution of the fluid in the case of a compression machine, Calculation of mass work and power, efficiencies, pumping phenomenon in compressors.

Chapter 8. Fans **((2 weeks))**
Role of turbomachinery in industrial installations, technological aspects.

Assessment method:
Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:::
1. P. HENRY, « Turbomachines hydrauliques », Presses Polytechniques et Universitaires Romandes, 1992.
2. M. Sedille, « Turbomachines Hydrauliques et thermiques », Masson 1970.

3. P. Henry, « Turbomachines hydrauliques », 1992.
4. Peng, "Fundamentals of Turbomachinery", Wiley and Sons 2008.
5. M. Pluviose, « Ingénierie des turbomachines**,** Circuits, vibrations, effets instationnaires et des exercices résolus », génie énergétique, Ellipses, 2003.
6. P. Chambadal, « La turbine à gaz », 1997
7. R. Bidard et J. Bonnin, « Energétique et turbomachines »**,** Eyrolles, 1979.
8. L. Vivier, « Turbines à vapeur et à gaz », 1965.
9. M. Pluviose, « Conversion d'énergie par Turbomachines », 2009.
10. J. Krysinski, « Turbomachines, théorie générale », OPU, Alger, 1986.
11. R. Bidard, J. Bonnin, « Energétique et Turbomachines », Eyrolles, Paris, 1979.
12. Jaumotte, « Turbopompes centrifuges », P.U. Bruxelles, 1979.
13. Jaumotte, « Turbomachines : ventilateurs, souflantes et compresseurs centrifuges », P.U. de Bruxelles, 1979.
14. Adam Troskolanski, « Les Turbopompes (Théorie Tracé et Construction) », Eyrolles, 1977.

Semester: 6
Teaching Unit: FU 3.2.1
Subject: Internal Combustion Engines
TH/S: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives: :
Know the operation of the different types of internal combustion engines both thermodynamically and mechanically.

Recommended prerequisites: :
Thermodynamics and mathematics of L1 and L2.

Content of the subject:
Chapter 1. General ((2 weeks))
Principle of operation and classification of thermal engines, fuels of internal combustion engines.
Chapter 2. The Thermodynamics of Motor Cycles ((4 weeks))
The Beau de Rochas cycle, the Diesel cycle, the Sabathé cycle, real cycles and yields, energy balance, fuel supply for gasoline engines, ignition system for gasoline engines, combustion.
Chapter 3. Real Cycle of an Internal Combustion Engine ((4 weeks))
Admission, Compression, Combustion, Expansion, Exhaust, The parameters indicated, The effective parameters, Construction of the diagram indicated theoretical.
Chapter 4. Dynamics of Reciprocating Engines ((3 weeks))
Connecting rod crank system: Kinematic study – Dynamic study.
Distribution system: Kinematic study – Dynamic study. Balancing.
Chapter 5. Performance and Characteristics of Reciprocating Engines ((2 weeks))
Performance parameters, Standards, Characteristics: Full load - partial loads - universal.

Assessment method:
Continuous control: 40%; Review: 60%.

Bibliographical Bibliographical references:::

1. J. B. Heywood, “Internal Combustion Fundamentals”, McGraw Hill Higher Education, 1989.
2. P. Arquès, « Conception et construction des moteurs alternatifs », Ellipse, 2000.
3. J-C. Guibet, « Carburants et moteurs », 1997.
4. P. Arquès, « Moteurs alternatifs à combustion interne (Technologie) », Masson édition, 1987.
5. U.Y. Famin Gorban, A.I., Dobrovolsky V.V, Lukin A.I. et al., « Moteurs marins à combustion interne », Leningrad: Sudostrojenij, 1989, 344p.
6. W. Diamant, « Moteurs à combustion interne », ECAM, 1984.
7. M. Desbois, R. Armao, « Le moteur diesel, Edition Foucher », Paris, 1974.
8. M. Menardon, D. Jolivet, « Les moteurs, Edition Chotard », Paris, 1986.
9. M. Desbois, « L’automobile : T1 : les moteurs à 4 temps et à deux temps. T2 : Les organes de transmission et d’utilisation », Edition Chotard, 1989.
10. P. Arques, « La combustion », Ellipses, Paris, 1987.
11. H. Memetau, « Techniques fonctionnelles de l’automobile : Le Moteur et ses auxiliaires », Dunod, Paris, 2002.

Semester: 6
Teaching Unit: FU 3.2.2
Subject 1: Refrigeration Machines and Heat Pumps
TH/S: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

To learn about the techniques of cold production and the main technical elements used in this vast field.

Recommended prerequisites:

Thermodynamics, turbomachinery, regulation, machine elements.

Content of the subject:

Chapter 1. Generalities ((2 weeks))

History of refrigeration, Carnot refrigeration cycle, Carnot cycle performance coefficient.

Chapter 2. Thermodynamic cycle of a vapor compression refrigeration machine ((4 weeks))

Representation of the basic thermodynamic cycle (on a T-s and P-h diagram),
Representation of the practical thermodynamic cycle (on a T-s and P-h diagram),
Thermal balance of the thermodynamic cycle,
Concept of refrigerants, Study of performance (COP,...),
Industrial applications of refrigeration.

Chapter 3. Components of a vapor compression refrigeration machine ((3 weeks))

Compressors, Evaporators, Condensers, Expansion valves.

Chapter 4. Other types of refrigeration machines ((3 weeks))

Principle of operation of an absorption refrigeration machine, Air refrigeration cycle.

Chapter 5. Thermodynamic cycle of a heat pump ((3 weeks))

Fluid diagram, Cycle reversing valve, Performance study (summer and winter seasons), Different types of heat pumps (geothermal, etc.).

Assessment method:

Continuous control: 40%; Exam 60%.

Bibliographical Bibliographical references:::

1. H. Recknagel, E-R. Schramek, E. Sprenger, « Génie climatique », Dunod,2013.
2. W. Maake, H.-J. Eckert, J-L. Cauchepin, « Le Pohlmann - Manuel technique du froid », PYC Livres.
3. J. Desmons, « Aide-mémoire de l'ingénieur : Génie climatique », Dunod.
4. F. Meunier, D. Mugnier, « La climatisation solaire. Thermique ou photovoltaïque », DUNOD, 2013.
5. F. Meunier, P. Rivet, M-F. Terrier, « Froid industriel - 2ème édition », DUNOD, 2010.
6. Horst Herr, « Génie énergétique et climatique Chauffage, froid, climatisation », **Dunod Tech** 2014.

Semester: 6
Teaching unit: FU 3.2.2
Subject 2: Heat Transfer 2
TH/S: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives::

Evaluate convected or radiated fluxes in different situations. Be able to model a thermal problem and solve it in stationary cases and simple geometries. Be able to make the right choice of materials for any thermal application.

Recommended prerequisites:

Thermodynamics, heat transfer1 and mathematics of L1 and L2.

Content of the subject:

Chapter 1. Continuation of transfers by convection of the first semester ((5 weeks))

Approximate resolution of boundary layer equations: Integral methods. Completely deal with the cases of the horizontal flat plate in forced convection and that of the vertical flat plate in natural convection. Deduce the relations Nu=f(Re, Pr) and Nu=f(Gr,Pr). Exact solution of laminar forced convection on a flat horizontal plate and flat vertical plate in natural convection. Deduce the relations Nu=f(Re, Pr) and Nu=f(Gr,Pr), compare with the approximate analysis. Laminar convection in a cylinder. Assumptions and resolution of the problem. Nusselt deduction with imposed temperature and imposed flux.

Chapter 2. Heat Transfer by Radiation ((6 weeks))

Introduction: Notions of solid angle. Mechanism of surface and volume radiative transfer. Definitions and general laws (Luminance, illumination, intensity, emittance, ...). Bouguer's formula, Kirchhoff's law and Draper's law. The black body (BB). Planck's law. Flux emitted by the BB in a spectral band. The Stefan-Boltzmann law. Radiative properties of surfaces and relations between them. Radiative exchanges between two infinitely extended parallel planes separated by a transparent medium. Concepts of screen. Radiative exchange between two black concave surfaces. Notions of form factors. Reciprocal relationships. Summation rule. Overlay rule. Symmetry rule. Form factors between infinitely long surfaces. The crossed strings method. Flux lost by a concave surface. Radiative exchanges between any n surfaces forming an enclosure. Enclosure rules for form factors. Illumination-radiosity method to evaluate exchanged fluxes. Electric analogy in radiative transfer. Radiative exchange between surfaces separated by an emitting and absorbing semi-transparent medium (STM), simplified method not involving the radiative transfer equation. Radiative properties of STM, Hottel's spherical cap. Emissivities and absorptivities of gaseous MST mixtures...

Chapter 3. Heat Exchangers and Boilers: ((4 weeks))

Notions on exchangers: Classification – Different types–Industrial uses–Evolution of temperatures in exchangers– Flow exchanged– Overall exchange coefficient– Calculation methods for exchangers– Mean logarithmic temperature difference method DTLM – Method of the NUT transfer units number– Comparison of the two methods. Boilers: Different types of boilers - Study of losses - Efficiency.

Assessment method:

Continuous control: 40%; Exam: 60%.

Bibliographical Bibliographical references:

1. J. F. Sacadura coordonnateur, « Transfert thermiques : Initiation et approfondissement », Lavoisier, 2015.
2. Kreith, F., Boehm, R.F., et. al., "Heat and Mass Transfer, Mechanical Engineering Handbook", Ed. Frank Kreith, CRC Press LLC, 1999.
3. A. Bejan and A. Kraus, "Heat Handbook Handbook", J. Wiley and sons 2003.
4. F. Kreith and M. S. Bohn, "Principles of Heat Transfer", 6th ed. Pacific Grove, CA: Brooks/Cole, 2001.
5. Y. A. Cengel, "Heat transfer, a practical approach", Mc Graw Hill, 2002.
6. Y. A. Cengel, "Heat and Mass Transfer", Mc Graw Hill.
7. H. D. Baehr and K. Stephan, "Heat and Mass transfer", 2nd revised edition, Springer Verlag editor, 2006.
8. J. L. Battaglia, A. Kuzik et J. R. Puiggali, « Introduction aux transferts thermiques », Dunod, 2010.
9. De Giovanni B. Bedat, « Transfert de chaleur », Cépaduès, 2012.
10. J. P. Holman, "Heat Transfer", 9th ed. New York: McGraw-Hill, 2002.
11. F. P. Incropera and D. P. DeWitt, "Introduction to Heat Transfer". 4th ed. New York: John Wiley & Sons, 2002.
12. J. Taine, J. P. Petit, « Transfert de chaleur et mécanique des fluides anisothermes », Dunod, 1988.
13. M. F. Modest. "Radiative Heat Transfer", New York: McGraw-Hill, 2014.
14. R. Siegel and J. R. Howell, "Thermal Radiation Heat Transfer", 3rd ed. Washington, D.C.: Hemisphere, 2003.
15. N. V. Suryanaraya, "Engineering Heat Transfer", St. Paul, Minn.: West, 1995.
16. H. D. Baehr and K. Stephan, "Heat and Mass transfer", 2nd revised edition, Springer Verlag.

Semester: 6
Teaching Unit: MU 3.2
Subject 1: Final project
TH/S: 45h00 (PW: 3h00)
Credits: 4
Coefficient: 2

Teaching objectives::
To assimilate in a comprehensive and complementary manner the knowledge from different subjects. To put into practice in a concrete way the concepts imparted during the training. To encourage a sense of autonomy and initiative in the student. To teach them to work in a col(Lab)orative framework by arousing their intellectual curiosity.

Recommended prerequisites::
The entire Bachelor's program.

Content of the subject::
The theme of the End of Cycle Project must come from a concerted choice between the teaching tutor and a student (or a group of students: a pair or trio). The subject matter must necessarily fit in with the training objectives and the student's actual abilities (Bachelor's level). It is also preferable that this theme takes into account the social and economic environment of the institution. When the nature of the project requires it, it can be subdivided into several parts.
Note:
During the weeks when students are immersing themselves in the purpose of their project and its feasibility (bibliographic research, search for software or materials necessary for the project, revision and consolidation of teaching directly related to the subject, etc.), the subject coordinator must take advantage of this face-to-face time to remind students of the essential content of the two subjects "Writing Methodology" and "Presentation Methodology" covered during the first two semesters of the common core.
At the end of this study, the student must submit a written report in which they must explain in the most explicit way possible:

The detailed presentation of the study topic, emphasizing its interest in its socio-economic environment.
The means used: methodological tools, **Bibliographical Bibliographical references::**, contacts with professionals, etc.
Analysis of the results obtained and their comparison with the initial objectives.
Criticism of the observed deviations and possible presentation of other additional details.
Identification of the difficulties encountered, highlighting the limits of the work done and the follow-up to be given to the work carried out.
The student or group of students then present their work (in the form of a brief oral presentation or on a poster) to their teaching tutor and an examining teacher who can ask

questions and thus evaluate the work accomplished both technically and in terms of presentation.

Assessment method:

Continuous control: 100%.

Semester: 6
Teaching Unit: MU 3.2
Subject: Refrigeration and Heat Pump (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
To understand the behavior of refrigeration machines in practice, their performance, and limitations.

Recommended prerequisites:
Refrigeration and Heat Pump Course

Content of the subject:;
Carry out some experiments related to refrigeration machines and heat pumps according to the avai(Lab)ility of means.

Assessment method:
Continuous control: 100%.

Semester: 6
Teaching unit: MU 3.2
Subject 3: Internal Combustion Engines (Lab)
TH/S: 15h00 (PW: 1h00)
Credits: 1
Coefficient: 1

Teaching objectives::

Apply the knowledge learned in class to evaluate the performance of internal combustion engines.

Recommended prerequisites::

Internal combustion engine course.

Content of the subject::

Plan some experiments related to internal combustion engines depending on the avai(Lab)ility of means.

Assessment method:

Continuous control: 100%.

Semester: 6
Teaching unit: MU 3.2
Subject 4: Control and Servo Control (Lab)
TH/S: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives::
Demonstrate typical examples of control and servo control on energy systems. For example, temperature or pressure control on refrigeration machines, flow control on heat exchangers, level control on boilers, speed control on turbomachinery, etc.

Recommended prerequisites::
Control course and applied energy subjects.

Content of the subject::
Provide some experiments related to control and servo control.

Assessment method:
Continuous control: 100%.

Semester: 6
Teaching Unit: DU 3.2
Subject 1: Renewable Energies
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::
Introduce the student to possible work prospects in the field of renewable energies such as hot water production installations, drying installations, electricity production in arid and off-grid areas, the notion of rendered service, the use of wind, biomass, and geothermal energy, etc.

Recommended prerequisites::
Thermodynamics, heat transfer, turbomachines, etc.

Content of the subject::
Chapter 1. Solar astronomy **((2 weeks))**
Chapter 2. Algerian solar potential **((2 weeks))**
Chapter 3. Thermal conversion of solar energy **((4 weeks))**

Flat solar collectors, Solar concentration: cylindrical, cylindro-parabolic-paraboloid, heliostats, Applications of solar thermal conversion, Solar heat storage.
Chapter 4. Photovoltaic conversion **((3 weeks))**
Physics of photovoltaic cells, Different types of direct conversion cells, Use of direct conversion panels and rendered service.
Chapter 5. Wind energy **((2 weeks))**
Wind potential, Different types of wind turbines, Use of wind turbines.
Chapter 6. Geothermal energy (**(1 week)**)
Geothermal potential in Algeria and utilization.
Chapter 7. Biomass (**(1 week)**)
Use of waste biomass.
Assessment method:
Exam: 100%.

Bibliographical Bibliographical references

1. B. Equer, J. Percebois, « Énergie solaire photovoltaïque, 1 : Physique et technologie de la conversion photovoltaïque », Ellipses, 1993.
2. P. Gipe, "Wind power : Renewable energy for home, farm, and business", Chelsea green publishing co, 2004.
3. A. Filloux, « Intégrer les énergies renouve(Lab)les », 2014.
4. J. Vernier, « Les énergies renouve(Lab)les », 2014.
5. B. Wiesenfeld, « Promesses et réalités des énergies renouve(Lab)les », 2013.
6. C. Dubois « Le guide de l'éolien, techniques et pratiques », Eyrolles, 2009.
7. D. Le Gouriérès, « Les éoliennes Théorie, conception et calcul pratique », Editions du Moulin Cadiou, 2008.
8. A. Damien, « La biomasse énergie Définitions, ressources et modes de transformation », 2013.
9. J. Lemale,La géothermie,Dunod, 2012.
10. P. Van de Maele, Jean-François Rocchi. « La géothermie et les réseaux de chaleur », Editeur(s) : ADEME, BRGM, 2003.
11. R. H. Charlier et Charles W. Finkl, "Ocean Energy: Tide and Tidal Power", 2008.
12. M. E. McCormick, "Ocean Wave Energy Conversion", 2007.
13. B. Multon, "Marine Renewable Energy Handbook", 2011.
14. P. Prouzet et A. Monaco, « Development of Marine Resources », 2014.

Semester: 6
Teaching Unit: DU 3.2
Subject 2: Cryogenics
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::

To learn about the different processes for producing very low temperatures. Techniques for liqFUying natural gas and producing liquid compounds from air.

Recommended prerequisites:

Thermodynamics and heat transfer.

Content of the subject::

Chapter 1. Thermodynamics review ((1 week))

Chapter 2. Gas cycles (Brayton) - study of the turbojet engine ((2 weeks))

Chapter 3. Phase-change cycles (Rankine) ((2 weeks))

Study of steam turbine cycles with compression and expansion.

Chapter 4. Main industrial methods for obtaining low temperatures ((3 weeks))

Chapter 5. Ideal liqFUaction cycles and minimum work ((3 weeks))

Chapter 6. Real liqFUaction cycles ((2 weeks))

Chapter 7. Gas separation ((2 weeks))

Descriptive aspects of some industrial gas

production processes.

Assessment method:
Exam: 100%.

Bibliographical references:

1. R.B. Scott, “Cryogenic engineering”, Van Nostrand, Princeton, 1959.
2. R.R. Conte, « Eléments de cryogénie », Masson, Paris ,1970.
3. G.G. Haselden, “Cryogenic fundamentals”, Academic Press, London, 1971.
4. R.A. Barron, “Cryogenic systems”, Oxford University Press, New York, 1985.

5. B.A. Hands, “Cryogenic engineering”, Academic Press, London, 1986.
6. S.W. Van Sciver, “Helium cryogenics”, Plenum Press, New York, 1989.
7. K.D. Timmerhaus and T.M. Flynn, “Cryogenic process engineering”, Plenum Press, New York, 1989.

Semester: 6
Teaching Unit: TU 3.2
Subject: Entrepreneurship and Business Management
TH/S: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives::

- Prepare students for professional integration after graduation;
- Develop entrepreneurial skills among students;
- Raise awareness among students and familiarize them with the possibilities, challenges, procedures, characteristics, attitudes, and skills required for entrepreneurship;
- Prepare students so that they can, one day, create their own company or, at least, better understand their work in an SME.

Recommended prerequisites::

No particular knowledge, except proficiency in the language of instruction.
Targeted skills:

Ability to analyze, synthesize, work in a team, communicate well orally and in writing, be autonomous, plan and meet deadlines, be reactive and proactive. Be sensitized to entrepreneurship through the presentation of an overview of management knowledge useful for creating activities.

Content of the subject::

Chapter 1 - Operational preparation for employment: **((2 weeks))**
Writing a cover letter and developing a CV, Job interview, …, Documentary research on jobs in the sector, Conducting interviews with professionals in the field and Simulating job interviews.
Chapter 2 - Entrepreneurship and entrepreneurial mindset: **((2 weeks))**
Entrepreneurship, Companies around you, Entrepreneurial motivation, Knowing how to set objectives, Knowing how to take risks
Chapter 3 - The profile of an entrepreneur and the job of an Entrepreneur: **((3 weeks))**
The qualities of an entrepreneur, Knowing how to negotiate, Knowing how to listen, The role of SMEs and PWEs in Algeria, The main success factors when creating a PWE/PME
Chapter 4 - Finding a good business idea: **((2 weeks))**
Creativity and innovation, Recognizing and evaluating business opportunities
Chapter 5 - Launching and operating a business: **((3 weeks))**
Choosing an appropriate market, Choosing the location of one's business, The legal forms of the company, Finding help and financing to start a business, Recruiting staff, Choosing suppliers
Chapter 6 - Development of the business plan: **((3 weeks))**
The Business Model and Business Plan, Realizing the business plan with the Business Model Canvas

Assessment method:
Exam: 100%

Bibliographical references:

- FayolleAlain, 2017. Entrepreneuriat théories et pratiques, applications pour apprendre à entreprendre.Dunod, 3e éd.

- LégerJarniou, Catherine, 2013, Le grand livre de l'entrepreneur. Dunod, 2013.

- PlaneJean-Michel, 2016, Management des organisations théories, concepts, performances. Dunod, 4ème éd.

- LégerJarniou, Catherine, 2017, Construire son Business Plan. Le grand livre de l'entrepreneur. Dunod,.

- Sion Michel, 2016, Réussir son business Méthodes, outils et astuces plan.Dunod ,4èmeéd.

- Patrick Koenblit, Carole Nicolas, Hélène Lehongre, Construire son projet professionnel, ESF, Editeur 2011.

- Lucie Beauchesne, Anne Riberolles, Bâtir son projet professionnel, L'Etudiant 2002.

- ALBAGLI Claude et HENAULT Georges (1996), La création d'entreprise en Afrique, ed EDICEF/AUPELF ,208 p.