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Democratic and People's Republic of Algeria

University

LOGO

Ministry of Higher Education and Scientific Research

TRAINING OFFER
LMD

ACADEMIC LICENSE

NATIONAL PROGRAM
2018 – 2019

Establishment	Faculty / Institute	Department

Domain	Sector	Speciality
Sciences and Technologies	Biomedical Engineering	Biomedical Engineering

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Democratic and People's Republic of Algeria

Ministry of Higher Education and Scientific Research

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Educational Committee
National Domain
Science and Technology

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The Lord and the Lord

2018 to 2019

Al-Qaeda	Al-Qaeda/Al-Qaeda	Al-Qaeda

The	Allah	Allah
The whole world	The whole world	ÿÿÿÿ ÿ ÿÿÿÿÿÿÿÿ

Degree Title: Biomedical Engineering

Year: 2018-2019

Summary

PART A

I – License Identity Card

1 - Location of the training:

Faculty (or Institute):

Department :

References of the license authorization order (attach a copy of the order)

2 - External partners:

Other partner establishments:

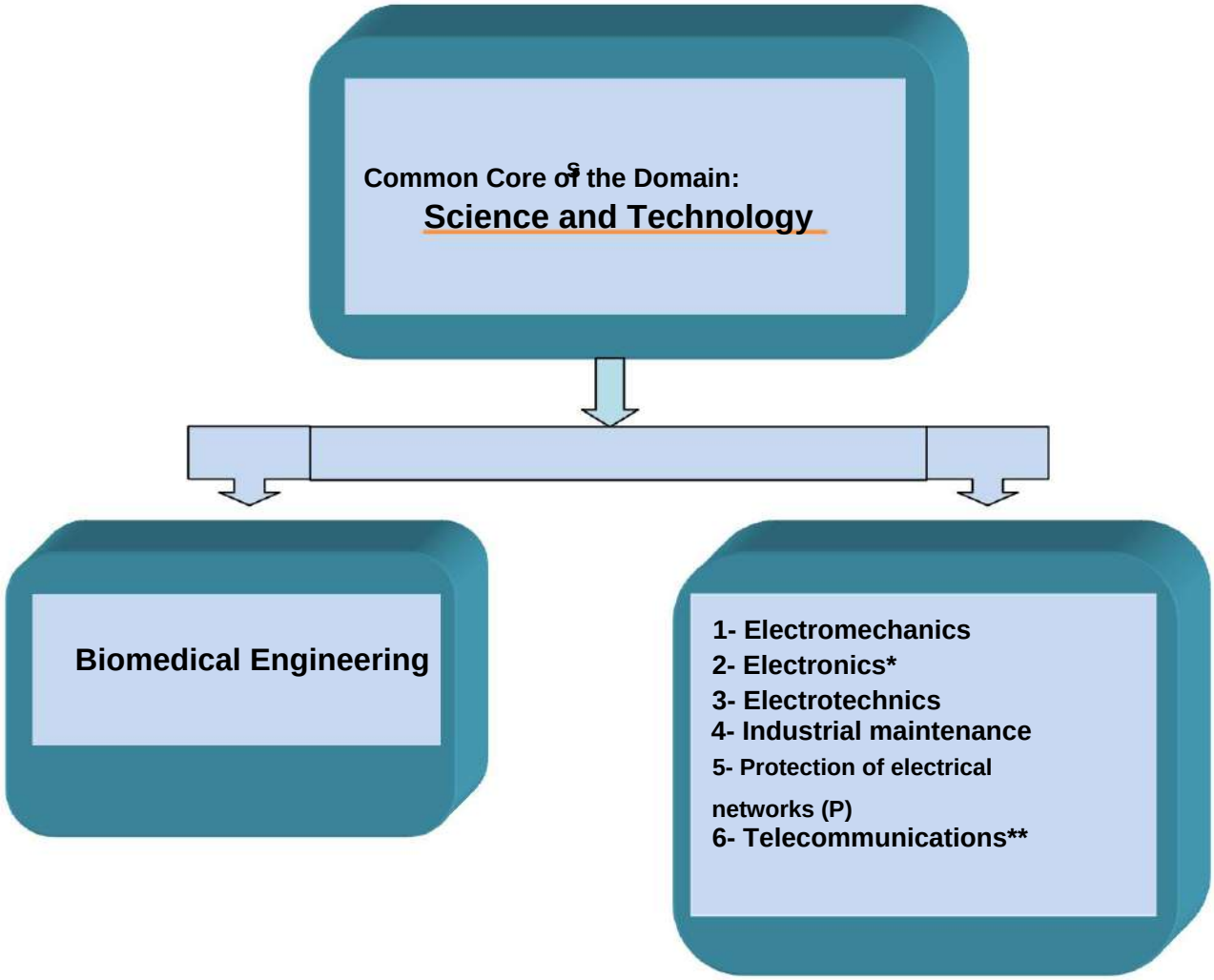
Businesses and other socio-economic partners:

International partners:

3 – Context and objectives of the training

A – General organization of the training: position of the project

Enter in the following diagram the License subject to this framework as well as all approved licenses (functional or not) at the establishment level and belonging to the same Group of sectors. Indicate with an asterisk any other license that is also supervised by a large proportion of the teachers involved in this license. Indicate frozen licenses with a double asterisk. Also mark with (P) any professional-type license.



B - Training objectives:

At the convergence of two seemingly very distant disciplines: electronics on the one hand, and life and health sciences on the other, biomedical engineering is booming.
This development has been made possible by recent technological advances in electronics.
The confrontation of these new technologies with the complexity of living things suggests the future emergence of multiple specialties and applications with promising and increasingly efficient economic potential.

The training suggested in this Biomedical Engineering Degree allows for the training of executives in the fields of engineering applied to biotechnologies in general and biomedicine in particular.

Its objective is, on the one hand, to meet the needs of the hospital and health sectors, through the training of qualified executives to take charge of the diagnosis, expertise and maintenance of biomedical equipment and, on the other hand, to set up an academic training and research activity in the field of health at the level of national universities.

The courses taught in this program are interwoven in the fields of material sciences, electronics, computer science, and basic medical sciences. Thus, courses in electricity, electronics, and medical concepts that allow students to make the connection between the medical equipment in question and the physiological parameters to be measured or the anatomical part of the human body to be diagnosed are introduced in the third and fourth semesters. During the fifth and sixth semesters, the courses are structured around medical instrumentation through the provision of fundamental knowledge in biophysics and biomaterials sciences, electrical and physiological signals, general electronics and measurement chains in biomedicine, medical informatics, and regulatory aspects in the healthcare environment.

C – Targeted profiles and skills:

The curriculum for this degree is based on the common core of the Science and Technology (ST) field. The courses provided during the fourth, fifth and sixth semesters are structured around essential knowledge in the Biomedical Engineering sector and particularly in that of electronics applied to medical instrumentation.

The qualifications acquired by executives who have completed this training allow them to: ÿ pursue Master's level studies
in specialties related to Engineering
biomedical or more generally with electronics.
ÿ work in various professional fields related to biotechnologies in general and biomedicine in particular, by carrying out the following missions: ÿ Install medical equipment, put it into service and ensure its performance. ÿ Check the operation of medical equipment and ensure its preventive or curative maintenance and draw up a maintenance contract for it. ÿ Diagnose a breakdown on medical equipment and identify the components

and/or defective parts.
ÿ Provide, if necessary, training for medical staff on the various health equipment and ensure their optimal use.

- ÿ Assist the engineer and the management of the health structure (hospital, health center, private clinic, etc.) in the choice and purchase of medical equipment.
- ÿ Work as a technical-commercial and medical equipment consultant for specialized companies or laboratories equipping themselves with or equipped with medical instruments.

Create and develop a company specializing in the field of biomedical instrumentation.

D – Regional and national employability potential:

The lack of managers in the field of biomedical engineering at the national level, whether in training establishments (Universities, Research Centres, Paramedical Training Centres, etc.) or in hospitals, means that the potential for integration of graduates from this training is significant.

At the end of their training, students in the Biomedical Engineering program can apply not only to pursue Master's degrees, but also to pursue various careers in the following sectors: ÿ Civil and military hospitals. ÿ Public and private clinics. ÿ Biological analysis laboratories. ÿ Functional rehabilitation centers. ÿ Socio-economic sectors.

E – Gateways to other specialties:

Semesters 1 and 2 common	
Sector	**Specialties**
Aeronautics	Aeronautics
Civil engineering	Civil engineering
Climate engineering	Climate engineering
Maritime engineering	Naval Propulsion and Hydrodynamics
	Naval construction and architecture
Mechanical Engineering	Energy
	Mechanical construction
	Materials Engineering
Hydraulic	Hydraulic
Transportation Engineering	Transportation Engineering
Metallurgy	Metallurgy
Optics and precision mechanics	Optics and photonics
	Precision mechanics
Public works	Public works
Automatic	Automatic
Electromechanics	Electromechanics
	Industrial maintenance
Electronic	Electronic
Electrical engineering	Electrical engineering
Biomedical Engineering	Biomedical Engineering
Industrial engineering	Industrial engineering
Telecommunication	Telecommunication
Process engineering	Process engineering
Mining engineering	Mining
	Valorization of mineral resources
Hydrocarbons	Hydrocarbons
Industrial hygiene and safety	Industrial hygiene and safety
Petrochemical industries	Refining and petrochemicals

Table of sectors and specialties in the Science and Technology field

Sector group A	Common semester 3
Sector	**Specialties**
Automatic	Automatic
Electromechanics	Electromechanics
	Industrial maintenance
Electronic	Electronic
Electrical engineering	Electrical engineering
Biomedical Engineering	Biomedical Engineering
Industrial engineering	Industrial engineering
Telecommunication	Telecommunication

Group of streams B	Common semester 3
Sector	**Specialties**
Aeronautics	Aeronautics
Civil engineering	Civil engineering
Climate engineering	Climate engineering
Maritime engineering	Naval Propulsion and Hydrodynamics
	Naval construction and architecture
Mechanical Engineering	Energy
	Mechanical construction
	Materials Engineering
Hydraulic	Hydraulic
Transportation Engineering	Transportation Engineering
Metallurgy	Metallurgy
Optics and precision mechanics	Optics and photonics
	Precision mechanics
Public works	Public works

Sector group C	Common semester 3
Sector	**Speciality**
Process engineering	Process engineering
Mining engineering	Mining
	Valorization of mineral resources
Hydrocarbons	Hydrocarbons
Industrial hygiene and safety	Industrial hygiene and safety
Petrochemical industries	Refining and petrochemicals

The courses which present common basic teachings between them (semester 3) have been grouped into 3 groups: A, B and C. These groups correspond schematically to the families of Electrical Engineering (Group A), Mechanical Engineering and Civil Engineering (Group B) and finally Process Engineering and Mining Engineering (Group C).

This degree offers multidisciplinary and cross-disciplinary teaching programs:

Multidisciplinary, in the sense that the courses in this specialty are 100% identical for semesters 1 and 2 with all the specialties in the Science and Technology field. On the other hand, the courses in semester 3 for all the specialties in the same group of sectors are also 100% identical.

Half	Group of sectors	Common lessons
Semester 1	A - B - C	(30/30) Credits
Semester 2	A - B - C	(30/30) Credits
Semester 3	A – B	(18 / 30) Credits
	A – C	(18 / 30) Credits
	B – C	(24 / 30) Credits

In a transversal manner, this Licence offers the student the choice of joining, if he expresses the desire and depending on the teaching places available:

- **All other specialties in the ST field at the end of semester 2.**
- **All specialties in the same group of courses at the end of semester 3.**
- **All specialties from another group of courses at the end of semester 3 (Subject to conditions of equivalence and opinion of the training team).**
- **All specialties in the same group of courses at the end of semester 4 (Subject to conditions of equivalence and opinion of the training team).**

F – Expected performance indicators of the training:

All training must meet the quality requirements of today and tomorrow. As such, to better assess the expected performance of the training offered on the one hand and by exploiting the flexibility and adaptability of the LMD system on the other hand, a number of mechanisms are proposed, for information purposes, for this degree to evaluate and monitor the progress of teaching, the training programs, student/teacher and student/administration relationships, the future of graduates of this degree as well as the assessments of the university's partners regarding the quality of the graduates recruited and/or the teaching provided. It is up to the training team to enrich this list with other criteria according to its own means and objectives.

Evaluation methods can be implemented through surveys, on-site monitoring of students in training, and surveys of recruited graduates and their employers. To achieve this, a report must be prepared, archived, and widely disseminated.

1. Evaluation of the training progress:

In addition to the regular meetings of the teaching committee, a meeting is held at the end of each semester. It brings together teachers and students from the class to discuss any problems encountered, possible improvements to teaching methods in particular, and the quality of training in general.

To this end, a more or less exhaustive list of indicators and methods envisaged for the evaluation and monitoring of this training project by the educational committee is proposed below:

Before the training:

ÿ Evolution of the rate of students who have chosen this degree (supply/demand ratio). ÿ Rate and quality of students who choose this degree.

During training:

ÿ Regularity of educational committee meetings. ÿ Compliance
of the themes of the End of Cycle Projects with the nature of the training. ÿ Quality of the relationship between students and the administration. ÿ Support provided to students
in difficulty. ÿ Student satisfaction rate with teaching
and methods
teaching.

Downstream of the training:

ÿ Student success rate per semester in this degree. ÿ Student dropout rate
(failures and dropouts). ÿ Identification of the causes of student failure.
ÿ Reorientation alternatives are offered to students who
fail. ÿ Rate of students who obtain their diplomas on time. ÿ Rate of students who continue their studies after the degree.

2. Evaluation of the progress of the lessons:

The teaching in this course is subject to regular evaluation (once a year) by the training team which will be made available, upon request, to the various institutions: National Educational Committee for the Field of Science and Technology, Regional Conferences, Vice-rectorate responsible for education, Faculty, etc.

Therefore, a system for evaluating programs and teaching methods can be established based on the following indicators:

ÿ Equipping teaching rooms and laboratories with materials and supports necessary for pedagogical improvement (projection systems (data shows), Wi-Fi connection, etc.). ÿ Existence of a communication and teaching platform
in which courses, tutorials and practical work are accessible to students and their questions are resolved.
ÿ Equipping teaching laboratories with materials and equipment in
adequacy with the content of the lessons.

ÿ Number of actual teaching weeks provided during a semester. ÿ Rate of completion of teaching programs. ÿ Digitization and conservation of End of Studies and/or End of Cycle dissertations. ÿ Number of practical exercises carried out as well as the multiplication of the type of practical exercises per subject (diversity of practical exercises). ÿ Quality of the institution's documentary collection in relation to the specialty and its accessibility.

ÿ Support from the socio-economic sector for training (company visits, company internships, courses and seminars given by professionals, etc.).

3. Integration of graduates:

A coordination committee is created, composed of training managers and members of the Administration, which is mainly responsible for monitoring the integration of graduates of the sector into professional life, for creating a monitoring file of graduates of the sector, for identifying and/or updating existing economic and industrial potential at regional and national level, for anticipating and encouraging new professions related to the sector in association with the chamber of commerce, the various employment support agencies, public and private operators, etc., for participating in any action concerning the professional integration of graduates (organization of events with socio-economic operators).

To carry out these missions, this committee has full discretion to conduct or commission any study or survey on the employment and post-employment of graduates. Below is a list of indicators and methods that could be considered to evaluate and monitor this operation:

ÿ Recruitment rate of graduates in the socio-economic sector in a position in direct relationship with training. ÿ Nature of jobs held by graduates. ÿ Diversity of opportunities. ÿ Establishment of an association of former graduates of the sector. ÿ Creation of small businesses by graduates of the specialty. ÿ Degree of satisfaction of employers.

G- Student assessment through continuous assessment and personal work

G1- Evaluation by Continuous Assessment:

The importance of continuous assessment methods on student training in terms of educational outcomes is no longer in doubt. In this regard, Articles 20, 21 and 22 of Order 712 of 3 November 2011 define and specify the methods and organization of continuous assessment of students according to the training course. The calculation of continuous assessment averages (supervised work and practical work) is done based on a weighting of all the elements that make up this assessment. These articles specify that this weighting is left to the discretion of the teaching team.

A survey conducted by the CPND-ST among all teachers in the various university establishments showed heterogeneity in the implementation of continuous assessment of students. We are therefore led to admit a real deficit in the effective management of this educational activity, which required us to

serious reflection on this subject which, combined with proposals from several establishments, resulted in the recommendations below.

The analysis of the various proposals from these establishments showed that, indeed, Articles 21 and 22 of Order 712 of 3 November 2011 are not explicit enough and deserve more clarification. These articles could be enriched by taking into account the following points, which represent a summary of the proposals collected.

1. Proposals relating to subjects with supervised work:

1.1. Preparation of the exercise series:

The teacher responsible for the subject must organize himself by proposing a series of exercises for each chapter of the course. This series must be exhaustive, with exercises for understanding the course and standard exercises to be solved during tutorial sessions.
These exercises must be prepared by the student before attending the tutorial. This preparation may be assessed. The assessment method is left to the discretion of the instructor in charge of the tutorial.

Exercises not resolved in TD can be the subject of personal work to be completed by groups of 3 to 4 students and submitted for assessment (deadline: 1 week).

1.2. Written questions:

Each end of a series of exercises (i.e. each end of a chapter) will be marked by a short written test. This test must be organized in collaboration with the subject head in order to ensure a fair assessment for all students (essentially when several teachers are involved in the tutorials).

1.3. Student participation in tutorials:

This participation must be assessed. The assessment method is left to the discretion of the teacher in charge of the tutorial.

1.4. Student attendance:

Student attendance is mandatory for tutorials and practical work. It is difficult to monitor attendance in lectures for undergraduate students, where class sizes are very large (lectures in lecture halls)
For master's programs where numbers are reduced, attendance must be compulsory in lectures and tutorials.

2. Case of methodological units (Practical work):

Just like the tutorials, the practical work must be prepared by the student. A test to check this preparation must be organized by the teacher before each manipulation (in the form of short comprehension questions, multiple choice questions, diagram of the manipulation, etc.). A report (by working group) must be submitted at the end of the practical work session. As such, the teacher must prepare a standard report (outline) to facilitate the work for the students so that they can actually submit it at the end of the practical work session.
At the end of the semester, the teacher organizes a practical test which summarizes all of the manipulations carried out by the student.

3. Regarding cross-curricular and discovery subjects that do not have tutorials or practical work:

It is very difficult to carry out continuous assessments in these subjects due to the absence of tutorial sessions and the very large number of students in most cases, particularly for universities with very large numbers of students.

However, the teacher in charge of this subject may, if he/she wishes, inform the students that he/she may possibly assess them (ongoing) by asking them to prepare presentations, to make reports, to research the course supplement, to use free software, to ask the students to watch at home a popular science film related to the subject (after having given them either the film on electronic media or having given them the internet link to this film) and then asking them to submit a written report or to make an oral presentation of the summary of this film, etc. The bonus for these activities is left to the discretion of the teacher and the training team who alone are able to define the best way to take this personal work into account in the overall mark of the final exam.

Along the same lines, and in the case where the number of students in this subject is reasonable (20 to 30 students), which may be the case for many masters, the head of the subject may consider continuous assessments of the student similar to what is done in subjects with tutorials. The only obligation to respect is that students should be informed of this procedure and validated during the first Academic Council.

In any case, the teacher and the teaching team are free to include any type of assessment they deem appropriate to encourage students to take better charge of their course and, at the same time, combat the phenomenon of student absenteeism.
to the courses.

4. Harmonization of continuous monitoring:

Using a common assessment grid would promote the harmonization of these practices from one teacher to another, from one department to another, and from one institution to another. It would also provide a structuring and reassuring benchmark for students.
To do this, we propose below an indicative assessment grid which presents the different continuous assessments allowing us to evaluate the degree of acquisition of students' skills, whether in terms of knowledge, analytical skills or synthesis abilities.

It should be noted that these assessments are not intended to "trap" students by imposing very difficult continuous assessments on them. On the contrary, it is a matter of "honestly" assessing the degree of assimilation of the various skills and knowledge taught to the student in complete objectivity. In the same spirit, we would gain by promoting the contractualization of the assessment of learning by specifying, for example, the success criteria and good practices that would lead to correct and precise answers to the questions. Thus, the assessment would mainly focus on the acquired knowledge that has been the subject of training by giving exercises related to what has been prepared in TD without forgetting, however, to assess the ability of students to mobilize their skills in more complex situations.

4-1 Practical work:

Preparation of exercise series and personal work (homework to be submitted, presentations, etc.)	30%	06 points
Written questions (minimum 2 questions including one proposed by the subject manager)	50%	10 points
Student participation in tutorials	20%	04 points
Total	100%	20 points

4.2 Practical work:

Practical work preparation tests Report	20%	04 points
(must be submitted at the end of the practical work session)	40%	08 points
Practical test at the end of the semester on all the manipulations carried out by the student.	40%	08 points
Total	100%	20 points

G2- Student's personal work:

The student's personal work is part of the LMD spirit. A very substantial amount of time has been allocated to it each week: approximately 50% of the total training time (see the "Overall Training Summary" table in this training offer).
A survey conducted by the CPND-ST among training teams across all university establishments indicated that time spent on student personal work could be used wisely, under good teacher supervision, rationally and in various forms. The tasks that would then be completed by volunteer students would be evaluated and counted (as a bonus) in their overall continuous assessment grade. The rate of this bonus is left to the discretion of the teaching teams.

The synthesis of the different proposals can be summarized in the following points:

1. Homework:

In order to enrich the knowledge and strengthen the training of students, they will be asked to carry out additional homework guided by their course or tutorial teachers. This type of work will involve, for example, encouraging students to do research to answer specific and/or conflicting questions raised during the course, solving a difficult exercise, reviewing in detail the demonstration of a theorem, researching the complement to a course, using free software or a CAD-CAM tool to make applications and simulations related to the course, etc. These activities can be evaluated, graded and registered as a bonus for the students who complete them.

2. Mini-course project:

The mini-course project (1 to 3 weeks) is an effective way to prepare students for the methodology of expression, writing and documentary research. It is a means that allows them to put into practice the techniques learned in the cross-curricular subjects. It also allows them to develop the spirit of group work.

The theme of the mini course project must be well targeted and decided by the teacher for a group of students (2 to 5 maximum), sanctioned by a single report (10 pages maximum) and a short collective oral presentation (preferably with audio-visual support). A mark, common to the group, is awarded according to an evaluation grid (presentation of the document and use of bibliographic resources, oral presentation, respect for time, answers to questions, etc.) and will then be counted, as a bonus, in the continuous assessment mark.

3. Report of a visit, an educational outing or a discovery and/or immersion course:

Visits, educational outings, discovery and/or immersion courses are opportunities for students that can help them better understand the reality of the working world and help them achieve better professional integration later on.
Administrative managers and teachers must encourage, as much as possible, this very important aspect of training and ensure the organization of educational visits and outings throughout the training course.
They must also help/encourage students to prospect in economic institutions with the aim of finding (in L3 and M1) discovery and/or immersion internships of one to two weeks in the industrial environment during the winter and spring holidays.

In this context, teachers must ensure that students take notes during these outings and require reports (reports of a few pages). This activity can be evaluated, graded, and recorded as a bonus for the student who completes it. Students can be offered templates to help them present their internship report effectively.

4. Participation in scientific events:

In order to instill a scientific spirit in students (especially for higher education students), they should be guided and encouraged to participate in round tables, laboratory seminars and conferences organized within their faculty and/or institution. It is even advisable to encourage these students to attend conferences related to their specialty outside their university at exhibitions, fairs and other events.
This activity can be assessed, graded and entered as a bonus for the student who completes it.

5. Use of New Information and Communication Technologies:

ICTs are very attractive to students. Teachers should encourage them to use these technologies to create spaces for exchange among themselves (promotion pages, discussion forums on a specific course issue, etc.). The teacher can also participate in the group as an online evaluator. This activity can be evaluated, graded, and recorded as a bonus for students who participate.

Conclusion :

Student autonomy, considered a lever for success, is largely based on the personal work that the student is required to do, by appropriating the resources and tools made available to them. All of this must, of course, be supervised and formalized within the framework of the educational monitoring and support that must be provided jointly by the university teacher and the administrative manager throughout the training course.

This autonomy will allow him to build his professional identity based on his aspirations, his abilities and his achievements or even to build his academic career in the pursuit of higher education.

4 - Human resources available:

A: Supervision capacity (expressed in number of students that can be supported):

Number of students:

B: Internal teaching team mobilized for the specialty: (To be completed and endorsed by the faculty or institute)

First and last name	Graduation Diploma	Specialty diploma (Master, doctorate)	Grade	Subjects to be taught	Signing in

Departmental visa

Faculty or institute visa

C: External teaching team mobilized for the specialty: (To be completed and endorsed by the faculty or institute)

First and last name	Establishment of attachment	Graduation Diploma	Specialty diploma (Master, doctorate)	Grade	Subjects to be taught	Signing in

Departmental visa

Faculty or institute visa

D: Overall summary of human resources mobilized for the specialty (L3):

Grade	Internal Staff	External Staff	Total
Teachers			
Lecturers (A)			
Lecturers (B)			
Assistant Professor (A)			
Assistant Professor (B)			
Other (*)			
Total			

(*) Technical and support staff

5 - Material resources specific to the specialty

A- Educational Laboratories and Equipment: Sheet of existing educational equipment for the practical work of the planned training (1 sheet per laboratory)

Lab title:

Student capacity:

No.	Equipment designation	Number	Observations

B- Internships and company training: (see agreements/conventions section)

Internship location	Number of students	Duration of the internship

C- Documentation available at the establishment level specific to the training offered (Mandatory field):

D- Personal work and ICT spaces available at department and faculty level:

II – Half-yearly organization sheets for the specialty courses

Semester 1

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Hourly Volume Biannual (15 weeks)	Work Complementary in Consultation (15 weeks)	Assessment method	
	Titled			Course	TD	TP			Control Continuous	Exam
Fundamental EU Code: UEF 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 EU Code: UEM 1.1 Credits: 9 Coefficients: 5	Physics 1 Practical Work	2	1			1h30	10:30 p.m.	27:30	100%	
	Chemistry 1 practical work	2	1			1h30	10:30 p.m.	27:30	100%	
	Computer Science 1	4	2	1h30		1h30	45h00	55h00	40%	60%
	Writing methodology	1	1	1h00			3:00 p.m.	10:00 a.m.		100%
EU Discovery Code: UED 1.1 Credits: 1 Coefficients: 1	Careers in Science and Technology 1	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
Transversal EU Code: UET 1.1 Credits: 2 Coefficients: 2	Foreign language 1 (French and/or English)	2	2	3h00			45h00	5:00 a.m.		100%
Total semester 1		30	17	4:00 p.m.	4:30 a.m.	4:30 a.m.	375 hours	375 hours		

Semester 2

Teaching unit	Materials	Credits	Weekly hourly volume				Hourly Volume Biannual (15 weeks)	Work Complementary in Consultation (15 weeks)	Assessment method	
	Titled		Coefficient	Course	TD	TP			Control Continuous	Exam
Fundamental EU Code: UEF 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 EU Code: UEM 1.2 Credits: 9 Coefficients: 5	Physics 2 Practical Work	2	1			1h30	10:30 p.m.	27:30	100%	
	Chemistry 2 practical work	2	1			1h30	10:30 p.m.	27:30	100%	
	Computer Science 2	4	2	1h30		1h30	45h00	55h00	40%	60%
	Presentation methodology	1	1	1h00			3:00 p.m.	10:00 a.m.		100%
EU Discovery Code: UED 1.2 Credits: 1 Coefficients: 1	Careers in Science and Technology 2	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
Transversal EU Code: UET 1.2 Credits: 2 Coefficients: 2	Foreign language 2 (French and/or English)	2	2	3h00			45h00	5:00 a.m.		100%
Total semester 2		30	17	4:00 p.m.	4:30 a.m.	4:30 a.m.	375 hours	375 hours		

Semester 3

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Hourly Volume Biannual (15 weeks)	Work Complementary in Consultation (15 weeks)	Assessment method	
	Titled			Course	TD	TP			Control Continuous	Exam
Fundamental EU Code: UEF 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 EU Code: UEF 2.1.2 Credits: 8 Coefficients: 4	Fundamental Electronics 1	4	2	1h30	1h30		45h00	55h00	40%	60%
	Fundamental Electrical Engineering 1	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological EU Code: UEM 2.1 Credits: 9 Coefficients: 5	Probability and statistics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Computer Science 3	2	1			1h30	10:30 p.m.	27:30	100%	
	Practical work in Electronics and Electrical Engineering	2	1			1h30	10:30 p.m.	27:30	100%	
	TP Waves and vibrations	1	1			1 hour	3:00 p.m.	10:00 a.m.	100%	
EU Discovery Code: UED 2.1 Credits: 2 Coefficients: 2	State of the art of electrical engineering	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
	Energy and environment	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
Transversal EU Code: UET 2.1 Credits: 1 Coefficients: 1	Technical English	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
Total semester 3		30	17	1:30 p.m.	7:30 a.m.	4:00 a.m.	375 hours	375 hours		

Semester 4

Teaching unit	Materials	Credits	Weekly hourly volume				Volume Hourly Biannual (15 weeks)	Work Complementary in Consultation (15 weeks)	Assessment method	
	Titled		Coefficient	Course	TD	TP			Control Continuous	Exam
Fundamental EU Code: UEF 2.2.1 Credits: 10 Coefficients: 5	Physical quantity sensors	6	3	3h00	1h30		67h30	82h30	40%	60%
	Combinatorial and sequential logic	4	2	1h30	1h30		45h00	55h00	40%	100%
Fundamental EU Code: UEF 2.2.2 Credits: 8 Coefficients: 4	Numerical methods	4	2	1h30	1h30		45h00	55h00	40%	60%
	Signal theory	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological EU Code: UEM 2.2 Credits: 9 Coefficients: 5	Electrical and electronic measurements	3	2	1h30		1 hour	37h30	37h30	40%	60%
	TP Physical quantity sensors	2	1			1h30	10:30 p.m.	27:30	100%	
	Practical work on combinatorial and sequential logic	2	1			1h30	10:30 p.m.	27:30	100%	
	Numerical Methods Practical Work	2	1			1h30	10:30 p.m.	27:30	100%	
EU Discovery Code: UED 2.2 Credits: 2 Coefficients: 2	Anatomy and physiology	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
	Medical imaging	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
Transversal EU Code: UET 2.2 Credits: 1 Coefficients: 1	Expression and communication techniques	1	1	1h30			10:30 p.m.	2:30 a.m.		100%
Total semester 4		30	17	1:30 p.m.	6:00 a.m.	5:30 a.m.	375 hours	375 hours		

Semester 5

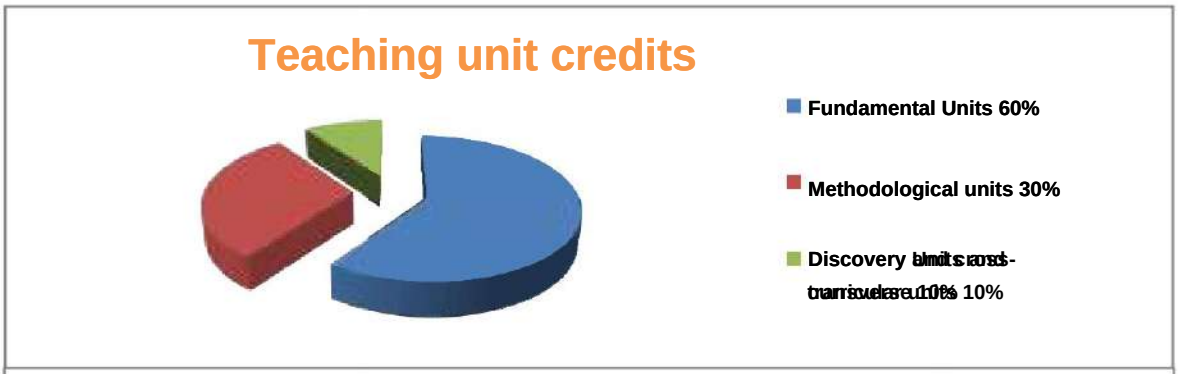
Unit teaching	Materials Titled	Credits	Coefficient	Hourly volume weekly Course	TD	TP		Volume Hourly Biannual (15 weeks)	Work Complementary in consultation (15 weeks)	Assessment method Control Continuous	Exam
Fundamental EU Code: UEF 3.1.1 Credits: 10 Coefficients: 5	Continuous servos and regulation	6	3	3h00	1h30			67h30	82h30	40%	60%
	General electronics	4	2	1h30	1h30			45h00	55h00	40%	60%
Fundamental EU Code: UEF 3.1.2 Credits: 8 Coefficients: 4	Signal processing	4	2	1h30	1h30			45h00	55h00	40%	60%
	Biophysics	4	2	1h30	1h30			45h00	55h00	40%	60%
Methodological EU Code: UEM 3.1 Credits: 9 Coefficients: 5	TP Servos and Regulation	2	1				1h30	10:30 p.m.	27:30	100%	
	General Electronics Practical Work	2	1				1h30	10:30 p.m.	27:30	100%	
	Medical informatics	3	2	1h30			1 hour	37h30	37h30	40%	60%
	Biophysics practical work and signal practical work	2	1				1h30	10:30 p.m.	27:30	100%	
EU Discovery Code: UED 3.1 Credits: 2 Coefficients: 2	Waves and applications in Medical	1	1	1h30				10:30 p.m.	2:30 a.m.		100%
	Terminology and standards in biomedicine	1	1	1h30				10:30 p.m.	2:30 a.m.		100%
Transversal EU Code: UET 3.1 Credits: 1 Coefficients: 1	Computer-assisted maintenance	1	1	1h30				10:30 p.m.	2:30 a.m.		100%
Total semester 5		30	17	1:30 p.m.	6:00 a.m.		5:30 a.m.	375 hours	375 hours		

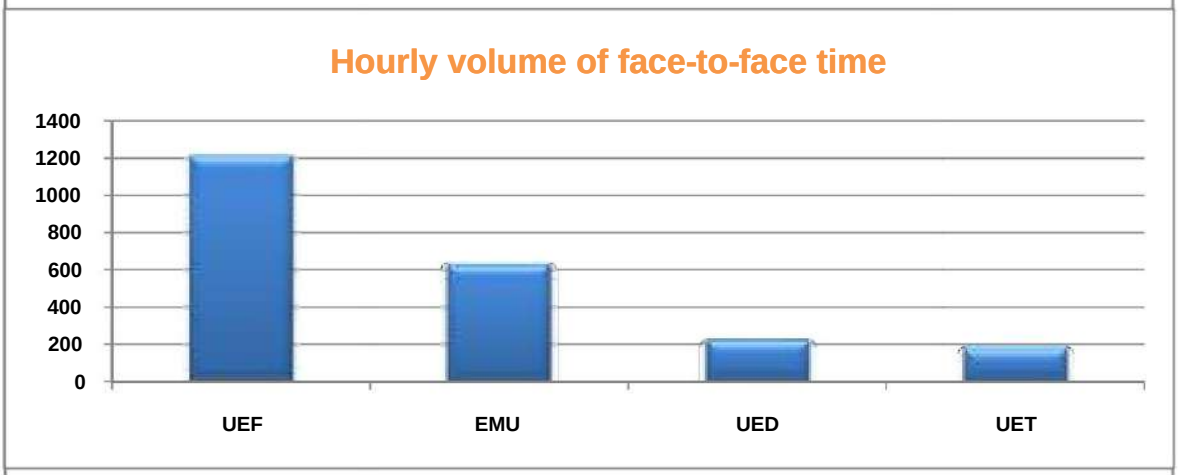
Semester 6

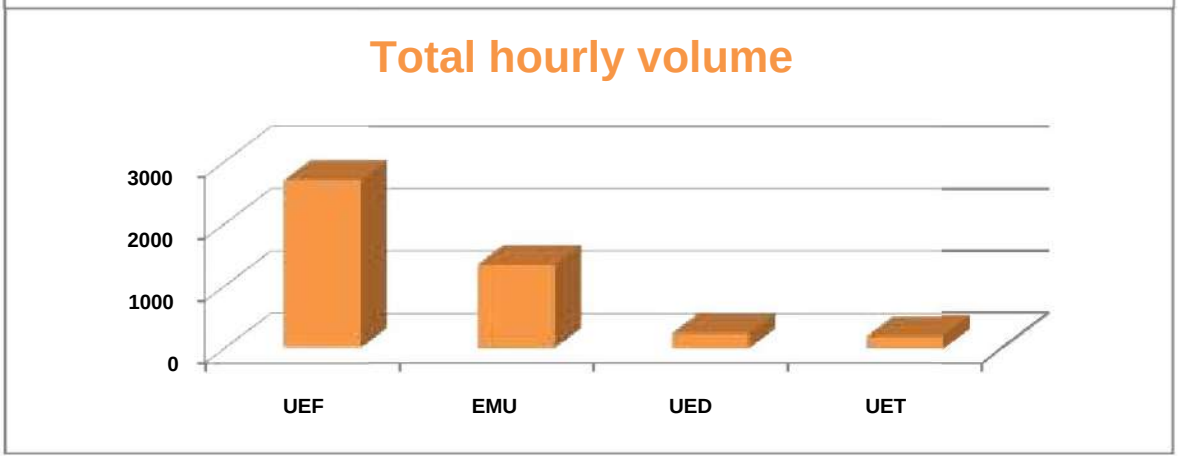
Teaching unit	Materials	Credits	Weekly hourly volume			Hourly Volume Biannual (15 weeks)	Work Complementary in Consultation (15 weeks)	Assessment method	
	Titled		Coefficient	Course TD TP				Control Continuous	Exam
Fundamental EU Code: UEF 3.2.1 Credits: 10 Coefficients: 5	Digital acquisition chain	6	3	3h00 1h30		67h30	82h30	40%	60%
	Biomaterials	4	2	1h30 1h30		45h00	55h00	40%	60%
Fundamental EU Code: UEF 3.2.2 Credits: 8 Coefficients: 4	Medical instrumentation	4	2	1h30 1h30		45h00	55h00	40%	60%
	Processing of physiological signals	4	2	1h30 1h30		45h00	55h00	40%	60%
Methodological EU Code: UEM 3.2 Credits: 9 Coefficients: 5	End of Cycle Project (Hospital environment)	4	2		3:00 a.m.	45h00	55h00	100%	
	Digital acquisition chain practical work	2	1		1h30	10:30 p.m.	27:30	100%	
	Instrumentation and signal TP	2	1		1h30	10:30 p.m.	27:30	100%	
	Models	1	1		1 hour	3:00 p.m.	10:00 a.m.	100%	
EU Discovery Code: UED 3.2 Credits: 2 Coefficients: 2	Device security in Biomedical	1	1	1h30		10:30 p.m.	2:30 a.m.		100%
	Elements of robotic systems	1	1	1h30		10:30 p.m.	2:30 a.m.		100%
Transversal EU Code: UET 3.2 Credits: 1 Coefficients: 1	Professional project and business management	1	1	1h30		10:30 p.m.	2:30 a.m.		100%
Total semester 6		30	17	12:00 6:00	7:00	375 hours	375 hours		

Overall training summary:

EU / VH	UEF	EMU	UED	UET	Total
Course	720h00	120h00	225h00	6:00 p.m.	1245h00
TD	495h00	10:30 p.m.	---	---	5:17 p.m.
TP	---	487h30	---	---	487h30
Personal work	1485h00	720h00	25h00	8:00 p.m.	2250h00
Other (specify)	---	---	---	---	---
Total	2700h00	1350h00	250h00	8:00 p.m.	4500h00
Credits	108	54	10	8	180
% in credits for each EU	60%	30%	10%		100%







III - Detailed program by subject

Semester: 1

Teaching unit: UEF 1.1 Subject 1:

Mathematics 1 VHS: 67h30 (Lecture:

3h00, TD: 1h30)

Credits: 6

Coefficient: 3

Teaching objectives

This first mathematics subject is particularly dedicated to standardizing 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 used in the field of Science and Technology.

Recommended prior knowledge

Basic concepts of mathematics for final year classes (sets, functions, equations, etc.).

Content of the material:

Chapter 1. Methods of Mathematical Reasoning 1-1 Direct (1 Week)
Reasoning. 1-2 Reasoning by Contraposition. 1-3 Reasoning by Absurdity. 1-4 Reasoning by Contraexample. 1-5 Reasoning by Recurrence.

Chapter 2. Sets, Relations and Applications 2.1 Set Theory. (2 Weeks)
2-2 Order Relation, Equivalence Relations. 2-3 Injective, Surjective, Bijective Application: Definition of an Application, Direct Image, Reciprocal Image, Characteristic of an Application.

Chapter 3. Real functions with one 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 4-1 (3 Weeks)
Power Function. 4-2 Logarithmic Function. 4-3 Exponential Function. 4-4 Hyperbolic Function. 4-5 Trigonometric Function. 4-6 Inverse Function

Chapter 5. Limited Development 5-1 (2 Weeks)
Taylor's Formula. 5-2 Limited Development. 5-3 Applications.

Chapter 6. Linear Algebra 6-1 (4 Weeks)
Laws and internal composition. 6-2 Vector space, basis, dimension (definitions and elementary properties). 6-3 Linear application, kernel, image, rank.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1- K. Allab, Elements of analysis, Function of a real variable, 1st & 2nd years of university, Office of University Publications.

2- J. Rivaud, Algebra: Preparatory Classes and University Volume 1, Exercises with Solutions, Vuibert.

3- N. Faddeev, I. Sominski, Collection of exercises in higher algebra, Moscow Edition 4- M. Balabne, M. Duflo, M. Frish, D. Guegan, Geometry – 2nd year of the 1st cycle preparatory classes, Vuibert University.

5- B. Calvo, J. Doyen, A. Calvo, F. Boshet, Algebra exercises, 1st scientific cycle preparation for the grandes écoles 2nd year, Armand Colin – Collection U.
6- J. Quinet, Elementary course in higher mathematics 1- Algebra, Dunod.
7- J. Quinet, Elementary course in higher mathematics 2- Usual functions, Dunod.
8- J. Quinet, Elementary course in higher mathematics 3- Integral calculus and series, Dunod.
9- J. Quinet, Elementary course in higher mathematics 4- Differential equations, Dunod.

Semester: 1

Teaching unit: UEF 1.1 Subject 2:

Physics 1 VHS: 67h30

(Lecture: 3h00, TD: 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 prior knowledge

Notions of mathematics and physics.

Content of the material:

Mathematical reminders 1- (2 Weeks)

Dimensional equations 2- Vector calculus: scalar product (norm), vector product, multivariate functions, derivation. Vector analysis: gradient, rotational operators, etc.

Chapter 1. Cinematics (5 Weeks)

1- Position vector in coordinate systems (Cartesian, cylindrical, spherical, curvilinear) - law of motion - Trajectory. 2- Velocity and acceleration in coordinate systems. 3- Applications: Movement of the material point in different coordinate systems. 4- Relative movement.

Chapter 2. Dynamics: (4 Weeks)

1- General: Mass - Force - Moment of force - Absolute and Galilean reference frame. 2- Newton's laws. 3- Principle of conservation of momentum. 4- Differential equation of motion. 5- Angular momentum. 6- Applications of the fundamental law for forces (constant, time-dependent, speed-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 assessment: 40%; Exam: 60%.

Bibliographic references: 1. A.

Gibaud, M. Henry; Physics course - Mechanics of the point - Course and corrected exercises; Dunod, 2007.

2. P. Fishbane et al. ; Physics For Scientists and Engineers with Modern Physics, 3rd Ed.; 2005.

3. PA Tipler, G. Mosca; Physics For Scientists and Engineers, 6th Ed., WH Freeman Company, 2008.

Semester: 1

Teaching unit: UEF 1.1 Subject 3:
Structure of the subject VHS: 67h30

(Lecture: 3h00, TD: 1h30)
Credits: 6

Coefficient: 3

Teaching objectives

Teaching this subject allows students to acquire basic chemistry formalisms, particularly in the subject describing the atom and chemical bonding, chemical elements and the periodic table with energy quantification. Making students better able to solve chemistry problems.

Recommended prior knowledge

Basic notions of mathematics and general chemistry.

Content of the material:

Chapter 1: Fundamental notions (2 Weeks)
States and macroscopic characteristics of the states of matter, changes of states of matter, notions of atom, molecule, mole and Avogadro's number, atomic mass unit, atomic and molecular molar mass, molar volume, Law of mass: Conservation of mass (Lavoisier), chemical reaction, Qualitative aspect of matter, Quantitative aspect of matter.

Chapter 2: Main constituents of matter (3 Weeks)
Introduction: Faraday's experiment: relationship between matter and electricity, Highlighting the constituents of matter and therefore of 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), Isotopy and relative abundance of different isotopes, Separation of isotopes and determination of the atomic mass and the average mass of an atom: Mass spectrometry: Bainbridge spectrograph, Binding and cohesion energy of nuclei, Stability of nuclei.

Chapter 3: Radioactivity – Nuclear reactions (2 Weeks)
Natural radioactivity (ÿ, ÿ and ÿ 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, The hydrogen atom in wave mechanics, Polyelectronic atoms in wave mechanics.

Chapter 5: Periodic Classification of Elements D. Mendeleev's (3 Weeks)
Periodic Classification, Modern Periodic Classification, Evolution and Periodicity of Physicochemical Properties of Elements, Calculation of Radii (Atomic and Ionic), Successive Ionization Energies, Electronic Affinity and Electronegativity (Mulliken Scale) by Slater's Rules.

Chapter 6: Chemical Bonds (3 Weeks)
Covalent bonding in Lewis theory, Polarized covalent bonding, dipole moment and partial ionic character of the bond, Geometry of molecules: Gillespie theory or VSEPR, Chemical bonding in the quantum model.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references 1.

Ouahes, Devallez, General Chemistry, OPU.
2. SS Zumdhal & coll., General Chemistry, De Boeck University.
3. Y. Jean, Electronic structure of molecules: 1 from the atom to simple molecules, 3rd edition, Dunod, 2003.

4. F. Vassaux, Chemistry in IUT and BTS.
5. A. Casalot & A. Durupthy, Inorganic Chemistry 2nd cycle course, Hachette.
6. P. Arnaud, Course in Physical Chemistry, Ed. Dunod.
7. M. Guymont, Structure of matter, Belin Coll., 2003.
8. G. Devore, General Chemistry: T1, study of structures, Coll. Vuibert, 1980.
9. M. Karapetiantz, Constitution of Matter, Ed. Mir, 1980.

Semester: 1

Teaching unit: UEM 1.1 Subject 1: Physics

1 VHS: 22:30 (TP: 1h30)

Credits: 2
Coefficient: 1

Teaching objectives

Consolidate the theoretical knowledge provided in the course through a number of practical exercises.

Recommended prior knowledge

Notions of mathematics and physics.

Content of the material:

5 manipulations minimum (3 hours / 15 days):

- Methodology for presenting practical work reports and calculating errors.
- Verification of Newton's 2nd law - Free fall -
Simple
pendulum - Elastic
collisions - Inelastic
collisions - Moment of inertia
- Centrifugal force

Assessment method:

Continuous assessment: 100%.

Semester: 1

Teaching unit: UEM 1.1 Subject 2:
Practical Chemistry 1 VHS:

10:30 p.m. (practical work: 1:30 p.m.)
Credits: 2

Coefficient: 1

Teaching objectives

Consolidate the theoretical knowledge provided during the structure of matter course through a number of practical exercises.

Recommended prior knowledge

Basic Chemistry Concepts.

Content of the material:

1. Laboratory safety

2. Preparation of solutions

3. Notions on uncertainty calculations applied to chemistry.

4. Acid-base dosage by colorimetry and pH-metry.

5. Acid-base dosage by conductivity meter.

5. Oxidation-reduction assay

6. Determination of water hardness

7. Determination of ions in water: determination of chloride ions by the Mohr method.

Assessment method:

Continuous assessment: 100%

Semester: 1

Teaching unit: UEM 1.1 Subject 3:

Computer science 1 VHS:

45h00 (Lecture: 1h30, Practical work: 1h30)

Credits: 4

Coefficient: 2

Objective and recommendations:

The objective of the subject is to enable students to learn to program using a high-level language (Fortran, Pascal, or C). The choice of language is left to the discretion of each institution.
The notion of algorithm must be taken into account implicitly during language learning.

Recommended prior knowledge

Basic concepts of web technology.

Content of the material:

Part 1. **Introduction to computing 1-** **(5 Weeks)**

Definition of computing 2- Evolution of computing and computers 3- Information coding systems 4- Operating principle of a computer 5- Hardware part of a computer 6- System part Basic systems (operating systems (Windows, Linux, Mac OS,...)

Programming languages, application software

Part 2. **Notions of algorithm and program 1-** **(10 Weeks)**

Concept of an algorithm 2- Representation in flowchart 3- Structure of a program 4- The 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/output operations 8- Control structures: Conditional control structures, Repetitive control structures

Computer Science

Practical Work 1: The practical work aims to illustrate the concepts taught during the course. These practical work must begin with the courses according to the following schedule: • Practical work for initiation and familiarization with the computer machine from a hardware and operating system point of view (exploration of the different functionalities of the OS) • Practical work for initiation to the use of a programming environment (Editing, Assembly, Compilation, etc.) • Practical work for applying the programming techniques s

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references 1-

John Paul Mueller and Luca Massaron, Algorithms for Dummies large format, 2017.

2- Charles E. Leiserson, Clifford Stein and Thomas H. Cormen, Algorithmics: course with 957 exercises and 158 problems, 2017.
3- Thomas H. Cormen, Algorithms: Basic Notions, 2013.

Semester: 1

Teaching unit: UEM 1.1 Subject
4: VHS writing methodology: 15h00
(Course: 1h00)
Credits: 1
Coefficient: 1

Teaching objectives

To familiarize and train students with current concepts of writing methodology in force in the Science and Technology profession. Among the skills to be acquired: Knowing how to present oneself; Knowing how to write a CV and a cover letter; Knowing how to position oneself in writing or orally in relation to an opinion or an idea; Mastering syntax and spelling in writing.

Recommended prior knowledge

Basic French. Basic principles of writing a document.

Content of the material:

Chapter 1. Concepts and generalities on writing techniques - Definitions, standards - Applications: writing a summary, a letter, a request **(2 Weeks)**

Chapter 2. Information retrieval, synthesis and exploitation - Information retrieval in libraries (Paper format: Books, Journals)
-Researching information on the Internet (Digital: Databases; Search engines, etc.).
- Applications **(3 Weeks)**

Chapter 3 Techniques and Procedures of Writing **(3 Weeks)**
- Basic Principles of Writing - Punctuation, Syntax, Sentences
- The length of sentences
- Division into paragraphs
- The use of a neutral style and writing in the third person
- Readability
- Objectivity
- Intellectual rigor and plagiarism

Chapter 4 Writing a Report **(4 Weeks)**
Cover pages, Summary, Introduction, Method, Results, Discussion, Conclusion, Bibliography, Appendices, Summary and Keywords

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

Assessment method:

Control Exam: 100%.

Bibliographic references:

1. J.-L. Lebrun, Practical guide to scientific writing, EDP Sciences, 2007.
2. M. Fayet, Successful Reporting, 3rd edition, Eyrolles, 2009.
3. M. Kalika, Master's thesis - Managing a thesis, Writing a report, Preparing a defense, Dunod, 2016.

4. M. Greuter, Succeeding in your dissertation and internship report, l'Etudiant, 2014 5. F. Cartier, Written and oral communication, Edition GEP- Groupe Eyrolles, 2012.
6. M. Fayet, Methods of written and oral communication, 3rd edition, Dunod, 2008.

7. E. Riondet, P. Lenormand, The big book of letter models, 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, The Practice of Correspondence, 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 Professional English, Springer, 2014.

Semester: 1

Teaching Unit: UED 1.1 Subject 1:

Careers in Science and Technology 1 VHS: 10:30 p.m.

(Course: 1.5 hours)

Credits: 1

Coefficient: 1

Subject objective: To

introduce the student, in a first step, to all the sectors covered by the Science and Technology field and in a second step to a range of careers that these sectors lead to. In the same context, this subject introduces the new challenges of sustainable development as well as the new careers that can result from it.

Recommended prior knowledge

None.

Content of the subject:

1. What are engineering sciences? (2 weeks)

The engineering profession, history and challenges of the 21st century, Search for a profession/recruitment advertisement by keyword, develop a simple job description (job title, company, main activities, skills required (knowledge, know-how, interpersonal skills)

2. Electronics, Telecommunications, Biomedical Engineering, Electrotechnics, Electromechanics, Optics & Precision Mechanics sectors: - Definitions, fields of application (Home (2 weeks)

automation, embedded applications for automobiles, Video surveillance, Mobile telephony, Optical fiber, Advanced scientific instrumentation, Imaging and medical instrumentation, Giant mirrors, Contact lenses, Transport and Distribution of electrical energy, Power generation plants, Energy efficiency, Maintenance of industrial equipment, Elevators, Wind turbines, etc.)

- Role of the specialist in these areas.

3. Automation and Industrial Engineering sectors: - Definitions, (1 week)

areas of application (Automated industrial chains, Numerical Control Machine Tools, Robotics, Inventory Management, Goods Traffic Management, Quality, - Role of the specialist in these areas.

4. Process Engineering, Hydrocarbons and Petrochemical Industries: (2 weeks)

- Definitions, Pharmaceutical industry, Food industry, Leather and textile industry, Biotechnologies, Chemical and petrochemical industry, Plastics industry, Energy sector (oil, gas), etc.

- Role of the specialist in these areas.

5. Sustainable development (SD): Definitions, (4 weeks)

Global issues (climate change, Demographic transitions, Depletion of resources (oil, gas, coal, etc.), Biodiversity loss, etc.), SD diagram (Sustainable = Viable + Livable + Equitable), SD actors (governments, citizens, socio-economic sector, international organizations, etc.), Global nature of SD challenges

6. Sustainable engineering: (4 weeks)

Definition, Principles of sustainable engineering (definitions of: sustainable energy/energy efficiency, sustainable mobility/ecomobility, resource recovery (water, metals and minerals, etc.), production

sustainable), Relevance of sustainable engineering in ST sectors, Relationship between sustainability and engineering, Responsibility of engineers in carrying out sustainable projects, ...

Student's personal work for this subject:

The teacher in charge of this subject can let his students know that he can always assess them by asking them to prepare job descriptions. Ask students to watch a popular science film at home related to the chosen job (after giving them either the film electronically or giving them the internet link to this film) and then ask them to submit a written report or make an oral presentation of the summary of this film, etc. The bonus for these activities is left to the discretion of the teacher and the training team who alone are able to define the best way to take this personal work into account in the overall grade of the final exam.

Group work: Development of job descriptions for professions in each sector based on recruitment advertisements found on job application sites (e.g. http://www.onisep.fr/Decouvrir-les-metiers, www.indeed.fr, www.pole-emploi.fr) (1 sector / group).

Depending on the capacity of the establishments, recommend calling on doctoral students and former graduates of the establishment in a tutoring/mentoring system where each group can call on its tutor/mentor to develop the job description/discover the different ST professions.

Assessment method:

100% exam

Bibliographic references:

1- What jobs for tomorrow? Publisher: ONISEP, 2016, Collection: Les Dossiers.
2- J. Douënel and I. Sédès, Choosing a career according to your profile, Editions d'Organisation, Collection: Employment & career, 2010.
3- V. Bertereau and E. Ratière, What Job Are You Made For? Publisher: L'Étudiant, 6th edition, Collection: Métiers, 2015.
4- The great book of professions, Publisher: L'Étudiant, Collection: Métiers, 2017.
5- Careers in the aeronautics and space industry, Collection: Parcours, Edition: ONISEP, 2017.
6- Careers in electronics and robotics, Collection: Parcours, Edition: ONISEP, 2015.
7- Environmental and sustainable development professions, Collection: Parcours, Edition: ONISEP, 2015.
8- Construction and public works trades, Collection: Parcours, Edition: ONISEP, 2016.
9- Transport and logistics professions, Collection: Parcours, Edition: ONISEP, 2016.
10- Energy professions, Collection: Parcours, Edition: ONISEP, 2016.
11- Mechanical professions, Collection: Parcours, Edition: ONISEP, 2014.
12- Careers in chemistry, Collection: Parcours, Edition: ONISEP, 2017.
13- Web professions, Collection: Parcours, Edition: ONISEP, 2015.
14- Careers in biology, Collection: Parcours, Edition: ONISEP, 2016.

Semester: 1

Teaching unit: UET 1.1 Subject 1:

French language 1 VHS: 10:30

p.m. (Course: 1.5 hours)

Credits: 1

Coefficient: 1

Teaching objectives:

This subject aims to develop the following four skills: Oral comprehension, Written comprehension and Oral expression, Written expression through reading and studying texts.

Recommended prior knowledge:

Basic French.

Content of the material:

Below we offer a set of themes that cover fundamental sciences, technologies, economics, social issues, communication, sports, health, etc. The teacher can choose texts from this list to develop them during the course. Otherwise, they are free to address other themes of their choice. The texts can be borrowed from various communication media: daily newspapers, sports or entertainment magazines, specialized or popular magazines, books, websites, audio and video recordings, etc.

For each text, the teacher helps the student develop their linguistic skills: listening, comprehension, and oral and written expression. In addition, they must use this text to identify the grammatical structures they will develop during the same class session. Here, for illustration purposes, we recall a set of grammatical structures that can be developed as examples. Of course, it is not a question of developing them all or in the same way. Some can be recalled and others in great detail.

Examples of themes	Grammatical structures
Climate change Pollution The electric car The robots Artificial intelligence The Nobel Prize The Olympic Games Sports at school The Sahara The currency Assembly line work Ecology Nanotechnologies Optical fiber The engineering profession The power plant Energy efficiency The smart building Wind energy Solar energy	Punctuation. Proper nouns, Articles. Grammatical functions: The noun, The verb, The pronouns, The adjective, The adverb. " The complement pronoun "le, la, les, lui, leur, y, en, me, te, … The agreements. The negative sentence. Don't…, Don't… yet, Don't… anymore, Don't… ever, Don't… point, … The interrogative sentence. Question with "Who, What, What", Question with "When, Where, How much, Why, How, Which, Which". The exclamatory sentence. Reflexive verbs. Impersonal verbs. The indicative tenses: Present, Future, Past Perfect, Simple Past, Imperfect. …

Assessment method:

Review: 100%.

Bibliographic references:

1. M. Badefort, Objective: International French Test, Edulang, 2006.
2. O. Bertrand, I. Schaffner, Passing the TCF, Exercises and training activities, Les éditions de l'école polytechnique, 2009.
3. M. Boulares, J.-L. Frerot, Progressive French Grammar with 400 exercises, Advanced Level, CLE International.
4. Collective, Besherelles: Grammar for all, Hatier.
5. Collective, Besherelles: Conjugation for all, Hatier.
6. Mr. Grégoire, Progressive French Grammar with 400 exercises, Beginner Level, CLE International, 1997.
7. A. Hasni et al., Training in teaching science and technology in secondary schools, University of Quebec Press, 2006.
8. J.-L. Lebrun, Practical guide to scientific writing, EDP Sciences, 2007.
9. JM Robert, Difficulties of French, Hachette,
10. C. Tisset, Teaching the French language at school: Grammar, Spelling and Conjugation, Hachette Education, 2005.
11. J. Bossé-Andrieu, Summary of the Rules of Grammar and Spelling, University Press Quebec, 2001.
12. J.-P. Colin, French made simple, Eyrolles, 2010.
13. Collective, French Assessment Test, Hachette, 2001.
14. Y. Delatour et al., Practical French grammar in 80 cards with corrected exercises, Hachette, 2000.
15. Ch. Descotes et al., The Exerciser: French Expression for the Intermediate Level, Presses Grenoble University, 1993.
16. H. Jaraush, C. Tufts, On the Vif, Heinle Cengage Learning, 2011.
17. J. Dubois et al., The Essentials – Spelling, Larousse, 2009.

Semester: 1

Teaching Unit: UET 1.1 Subject 1:

English Language 1 VHS: 10:30

p.m. (Course: 1.5 hours)

Credit: 1

Coefficient: 1

Objective:

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

Recommended prior knowledge:

Basic English.

Contents:

The English syllabus 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 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 also contain a terminology which means the translation of some words from English to French one. , the activity at the end of each session must include a translation of long statements which are selected from the texts.

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

Mode evaluation:

Exam: 100%.

References:

1. **J. Upjohn, S. Blattes, V. Jans, Minimum Competence in Scientific English, Office of University Publications, 1994.**
2. **AJ Herbert, The Structure of Technical English, Longman, 1972.**
3. **S. Berland-Delepine, Methodical grammar of modern English with exercises, 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, English: 1000 Words and Expressions from the Press: Vocabulary and Expressions from the Economic, Social and Political World, Fernand Nathan, 2006.

Semester: 2

Teaching unit: UEF 1.2 Subject 1:

Mathematics 2 VHS: 67h30 (Lecture:

3h00, TD: 1h30)

Credits: 6

Coefficient: 3

Teaching objectives

Students are led, step by step, towards understanding mathematics useful for their university studies. At 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; solve systems of linear equations using several methods.

Recommended prior knowledge

Basic concepts of mathematics (differential equation, integrals, systems of equations, etc.).

Content of the material:

Chapter 1: Matrices and Determinants (3 Weeks)
1-1 Matrices (Definition, Operation). 1-2 Matrix associated with a linear map. 1-3 Linear map associated with a matrix. 1-4 Change of basis, transition matrix.

Chapter 2: Systems of Linear Equations (2 Weeks)
2-1 Generalities. 2-2 Study of the Solution Set. 2-3 Methods for Solving a Linear System. Solving by Cramer's Method. Solving by the Inverse Matrix Method.
Resolution by the Gauss method

Chapter 3: Integrals 3-1 (4 Weeks)
Indefinite Integral, Property. 3-2 Integration of Rational Functions. 3-3 Integration of Exponential and Trigonometric Functions. 3-4 Integral of Polynomials. 3-5 Definite Integration

Chapter 4: Differential Equations 4-1 Ordinary (4 Weeks)
Differential Equations. 4-2 First-Order Differential Equations. 4-3 Second-Order Differential Equations. 4-4 Second-Order Ordinary Differential Equations with Constant Coefficient.

Chapter 5: Functions of Several Variables 5-1 (2 Weeks)
Limit, Continuity, and Partial Derivatives of a Function. 5-2 Differentiability. 5-3 Double and Triple Integrals.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1- F. Ayres Jr, Theory and Applications of Differential and Integral Calculus - 1175 corrected exercises, McGraw-Hill.

2- F. Ayres Jr, Theory and Applications of Differential Equations - 560 corrected exercises, McGraw-Hill.

3- J. Lelong-Ferrand, JM Arnaudiès, Mathematics Course - Differential Equations, Multiple Integrals, Volume 4, Dunod University.

4- M. Krasnov, Collection of problems on ordinary differential equations, Moscow Edition

5- N. Piskunov, Differential and Integral Calculus, Volume 1, Moscow
Edition 6- J. Quinet, Elementary Course in Higher Mathematics 3- Integral Calculus and Series, Dunod.
7- J. Quinet, Elementary course in higher mathematics 4- Differential equations, Dunod.
8- J. Quinet, Elementary course in higher mathematics 2- Usual functions, Dunod.
9- J. Quinet, Elementary course in higher mathematics 1- Algebra, Dunod.
10- J. Rivaud, Algebra: Preparatory Classes and University Volume 1, Exercises with Solutions, Vuibert.

11- N. Faddeev, I. Sominski, Collection of exercises in higher algebra, Moscow Edition.

Semester: 2

Teaching unit: UEF 1.2 Subject 2:

Physics 2 VHS: 67h30

(Lecture: 3h00, TD: 1h30)

Credits: 6

Coefficient: 3

Teaching objectives

To introduce the student to the physical phenomena underlying the laws of electricity in general.

Recommended prior knowledge

Mathematics 1, Physics 1.

Subject content:

Mathematical reminders: (1 week)

1- Elements of length, surface, volume in Cartesian, cylindrical, spherical coordinate systems. Solid angle, Operators (gradient, rotational, Nabla, Laplacian and divergence).

2- Multiple derivatives and integrals.

Chapter I. Electrostatics: (6 Weeks)

1- Electrostatic charges and fields. Electrostatic interaction force - Coulomb's law.

2- Electrostatic 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. Electrokinetics: (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 and 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 assessment: 40%; Exam: 60%.

Bibliographic references:

1. **J.-P. Perez, R. Carles, R. Fleckinger; Electromagnetism Foundations and Applications, Ed. Dunod, 2011.**
2. **H. Djelouah; Electromagnetism; Office of University Publications, 2011.**
3. **P. Fishbane et al. ; Physics For Scientists and Engineers with Modern Physics, 3rd ed. ; 2005.**
4. **PA Tipler, G. Mosca; Physics For Scientists and Engineers, 6th ed., WH Freeman Company, 2008.**

Semester: 2

Teaching unit: UEF 1.2 Subject 3:

Thermodynamics VHS: 67h30

(Lecture: 3h00, TD: 1h30)

Credits: 6

Coefficient: 3

Teaching objectives

Provide the necessary foundations of classical thermodynamics for applications to combustion and thermal machines. Homogenize students' knowledge. The skills to be acquired are: The acquisition of a scientific basis of classical thermodynamics; The application of thermodynamics to various systems; The statement, explanation and understanding of the fundamental principles of thermodynamics.

Recommended prior knowledge

Basic notions of mathematics and general chemistry.

Content of the material:

Chapter 1: Generalities on thermodynamics 1- (3 Weeks)
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- Transformations of the state of a system (operation, evolution). 7- Reminders o

Chapter 2: The 1st principle of thermodynamics: 1. (3 weeks)
Work, heat, internal energy, concept of conservation of energy. 2. The 1st principle of thermodynamics: statement, concept of internal energy of a system, application to ideal gas, enthalpy function, heat capacity, reversible transformations (isochoric, isobaric, isothermal, adiabatic).

Chapter 3: Applications of the first principle of thermodynamics to thermochemistry (3 weeks)

Heats of reaction, standard state, standard enthalpy of formation, enthalpy of dissociation, enthalpy of change of physical state, enthalpy of a chemical reaction, Hess's law, Kirchoff's law.

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

Chapter 5: The 3rd Principle 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 assessment: 40%; Exam: 60%.

Bibliographic references: 1. C.

Coulon, S. Le Boiteux S. and P. Segonds, Thermodynamics Physics - Course and exercises with solutions, Dunod Edition.

2. HB Callen, Thermodynamics, Course, Edition John Wiley and Sons, 1960 3. R. Clerac, C. Coulon, P. Goyer, S. Le Boiteux & C. Rivenc, Thermodynamics, Course and tutorials in thermodynamics, University of Bordeaux 1, 2003 4. O. Perrot, Course in Thermodynamics IUT of Saint-Omer Dunkerque, 2011 5. CL Huillier, J. Rous, Introduction to thermodynamics, Edition Dunod.

Semester: 2

Teaching unit: UEM 1.2 Subject 1: Physics

2 VHS: 45h00 (TP: 1h30)

Credits: 2
Coefficient: 1

Teaching objectives

Consolidate through practical work sessions the theoretical concepts covered in the Physics 2 course.

Recommended prior knowledge

Mathematics 1, Physics 1.

Content of the material:

5 manipulations minimum (3h00 / 15 days)

- Presentation of measuring instruments and tools (Voltmeter, Ammeter, Rheostat, Oscilloscopes, Generator, etc.).
- Kirchhoff's laws (mesh law, knot law).
- Thévenin's theorem.
- Association and measurement of inductances and capacities - Charging and discharging a capacitor -
Oscilloscope - Practical work on magnetism

Assessment method:

Continuous assessment: 100%

Semester: 2

Teaching unit: UEM 1.2 Subject 2:
Practical Chemistry 2 VHS:

10:30 p.m. (practical work: 1:30 p.m.)
Credits: 2
Coefficient: 1

Teaching objectives

Consolidate the theoretical concepts covered in the Thermodynamics course through practical work sessions.

Recommended prior knowledge

Thermodynamics.

Content of the material:

1. Ideal gas laws.
2. Water value of the calorimeter.
3. Specific heat: specific heat of liquid and solid bodies.
4. Latent heat: Latent heat of fusion of ice 5. Heat of reaction:
Determination of the energy released by a chemical reaction (HCl/NaOH)
6. Hess's Law
7. Vapor pressure of a solution.

Assessment method:

Continuous assessment: 100%

Semester: 2

Teaching unit: UEM 1.2 Subject 3:

Computer science 2 VHS:

45h00 (Lecture: 1h30, Practical work: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives

Master basic programming and algorithmic techniques. Acquire fundamental computer science concepts. The skills to be acquired are: Programming with a certain degree of autonomy; Designing algorithms from the simplest to the relatively complex.

Recommended prior knowledge

Know how to use the university website, file systems, Windows user interface, programming environment.

Content of the material:

Chapter 1: Indexed Variables (4 Weeks)

1- One-dimensional arrays: Representation in memory, Operations on arrays

2- Two-dimensional arrays: Representation in memory, Operations on two-dimensional arrays

Chapter 2: Functions and Procedures (6 Weeks)

1- Functions: Types of functions, declaration of functions, function calls

2- Procedures: Concepts of global variables and local variables, simple procedure, procedure with arguments

Chapter 3: Recordings and Files (5 Weeks)

1- Heterogeneous data structure

2- Structure of a record (notion of fields)

3- Manipulation of record structures

4- Concept of file

5- File access modes

6- Reading and writing to a file

Computer Science 2:

Plan a certain number of practical exercises to put into practice the programming techniques seen during the course.

- Practical work on applying programming techniques seen in class.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1- Algorithms for Dummies large format Book by John Paul Mueller (Informatiker, USA) and Luca Massaron 2017 2- Algorithmics:

course with 957 exercises and 158 problems Book by Charles E. Leiserson, Clifford Stein and Thomas H. Cormen 2017 3- Algorithms: Basic Notions Book by

Thomas H. Cormen 2013.

Semester: 2

Teaching unit: UEM 1.2 Subject 4:

VHS presentation methodology: 15h00 (Course: 1h00)

Credits: 1

Coefficient: 1

Teaching objectives

Provide the basics for a successful oral presentation. Skills to acquire include: Knowing how to prepare a presentation; Knowing how to deliver a presentation; Knowing how to capture the audience's attention; Understanding the pitfalls of plagiarism and understanding intellectual property regulations.

Recommended prior knowledge

Expression and communication techniques and writing methodology.

Content of the material:

Chapter 1: The Oral (3 Weeks)
Presentation Communication. Preparing an Oral Presentation. Different Types of Plans.

Chapter 2: Presenting an Oral Presentation (3 Weeks)
Structure of an Oral Presentation. Presenting an Oral Presentation.

Chapter 3: Plagiarism and Intellectual Property (3 Weeks)
1- Plagiarism: Definitions of plagiarism, sanctions for plagiarism, how to borrow the work of other authors, quotes, illustrations, how to be sure to avoid plagiarism?
2- Writing a bibliography: Definition, objectives, how to present a bibliography, writing the bibliography

Chapter 4: Presenting Written Work - (6 Weeks)
Presenting Written Work. Applications: Presenting an Oral Presentation.

Assessment method:

Review: 100%.

Bibliographic references:

1. M. Fayet, Methods of written and oral communication, 3rd edition, Dunod, 2008.
2. M. Kalika, Master's thesis – Managing a thesis, Writing a report, Preparing a defense, Dunod, 2016.

3. M. Greuter, Succeeding in your dissertation and internship report,
l'Etudiant, 2014 4. B. Grange, Succeeding in a presentation. Preparing impactful slides and communicating well in p
Eyrolles, 2009.
5. H. Biju-Duval, C. Delhay, All speakers, Eyrolles, 2011.
6. C. Eberhardt, Practical work with PowerPoint. Creating and laying out slides, Dunod, 2014.

7. F. Cartier, Written and oral communication, Edition GEP- Groupe Eyrolles, 2012.
8. L. Levasseur, 50 exercises for public speaking, 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: UED 1.2 Subject 1:

Careers in Science and Technology 2 VHS: 10:30 p.m.

(Course: 1.5 hours)

Credits: 1

Coefficient: 1

Objective of the subject:

To introduce the student, in a first step, to all the sectors covered by the Science and Technology Field and in a second step to a range of careers that these sectors lead to. In the same context, this subject introduces the student to the new challenges of sustainable development as well as the new careers that can result from it.

Recommended prior knowledge

None.

Content of the subject:

1. Industrial Hygiene and Safety (IHS) and Mining Engineering sectors: - Definitions and areas of application (Safety of property and people, Environmental problems, Exploration and exploitation of mining resources, etc.) (2 weeks)

- Role of the specialist in these areas.

2. Climate Engineering and Transport Engineering sectors: - Definitions, areas of application (Air conditioning, Intelligent buildings, Transport safety, Traffic management and road, air, naval transport, etc.) (2 weeks)

- Role of the specialist in these areas.

3. Civil Engineering, Hydraulics and Public Works sectors: - Definitions and areas of application (Construction materials, Major road and railway infrastructures, Bridges, Airports, Dams, Drinking water supply and sanitation, Hydraulic flows, Water resources management, Public works and land use planning, Smart cities, etc.) (2 weeks)

- Role of the specialist in these areas.

4. Aeronautics, Mechanical Engineering, Maritime Engineering and Metallurgy: (2 weeks)

- Definitions and fields of application (Aeronautics, Avionics, Automotive industry, Ports, Dikes, Production of industrial equipment, Steel industry, Metal transformation, etc.)

- Role of the specialist in these areas.

5. Approaches to sustainable production: Industrial ecology, Remanufacturing, Ecodesign. (2 weeks)

6. Measuring the sustainability of a process/product/service: Environmental analysis, Life cycle analysis (LCA), Carbon footprint, case studies/applications. (2 weeks)

7. Sustainable Development and Business: (3 weeks)

Definition of the business as an economic entity (notions of profit, costs, performance) and social entity (notion of corporate social responsibility), Impact of economic activities on the environment (examples), Challenges/benefits of sustainable development for the business, Means of engagement in a sustainable development approach (e.g. ISO 14001 certification, labeling (e.g. energy labeling, Ecolabel, Organic/AB Label, FSC Label, etc.), strategic sustainable development plan, Global Reporting Initiative (GRI)...), World rankings of the most sustainable companies (Dow Jones Sustainable Index, Global 100, etc.), Studies of

cases of successful/eco-responsible companies in the ST sectors (e.g. SIEMENS, Cisco, Henkel AG & Co, TOTAL, Peugeot, Eni SPA, etc.).

Personal work of the student for this subject: - Work in groups/ pairs: Reading articles on sustainable development and/or reports from successful and sustainable companies and preparation of summaries of the main actions undertaken in the field of sustainable development.

Examples of documents for reading and synthesis:

- **Case of ONA and ENIEM: Kadri, Mouloud, 2009, Sustainable development, the company and ISO 14001 certification, Market and organizations vol. 1 (No. 8), p. 201-215 (free online access: http://www.cairn.info/revue-marche-et-organisations-2009-1-page-201.htm)**
- **Mireille Chiroleu-Assouline. Sustainable development strategies for businesses. Ideas, The Review of Economic and Social Sciences, CNDP, 2006, pp. 32-39 (free online access: http://halshs.archives-ouvertes.fr/hal-00306217/document)**
- Web page on **TOTAL 's environmental and societal commitments : https://www.total.com/fr/engagement**
- **Sustainable mobility innovations from the PSA group: http://www.rapportannuel.groupe-psa.com/rapport-2015/engagements/dessolutions-innovantes-pour-des-transports-durables/**

Assessment method:

100% exam

Bibliographic references:

1- V. Maymo and G. Murat, The Sustainable Development and CSR Toolbox - 53 tools and methods, Edition: Dunod, 2017.

2- P. Jacquemot and V. Bedin, The encyclopedic dictionary of sustainable development, Edition: Sciences Humaines, 2017.

3- Y. Veyret, J. Jalta and M. Hagnerelle, Sustainable development: All the issues in 12 lessons, Edition: Autrement, 2010.

4- L. Grisel and Ph. Osset, Life Cycle Analysis of a Product or Service: Applications and Practical Implementation, 2nd Edition: AFNOR, 2008.

5- Sh. Shaked, N. Jolliet-Gavin, P. Crettaz, M. Saadé-Sbeih and O. Jolliet, Life Cycle Analysis: Understanding and Carrying Out an Eco-Assessment, 3rd Edition: PPUR, 2017.

6- G. Pitron and H. Védrine, The rare metal war: The hidden face of the energy and digital transition, Edition: Liens qui libèrent, 2018.

7- Environmental and sustainable development professions, Collection: Parcours, Edition: ONISEP, 2015.

Semester: 2

Teaching unit: UET 1.2 Subject 1:

French language 2 VHS: 10:30

p.m. (Course: 1:30 p.m.)

Credits: 1

Coefficient: 1

Teaching objectives:

This subject aims to develop the following four skills: Oral comprehension, Written comprehension, Oral expression, Written expression through reading and studying texts.

Recommended prior knowledge:

Basic French.

Content of the material:

Below we offer a set of themes that cover fundamental sciences, technologies, economics, social issues, communication, sports, health, etc. The teacher can choose texts from this list to develop them during the course. Otherwise, they are free to address other themes of their choice. The texts can be borrowed from various communication media: daily newspapers, sports or entertainment magazines, specialized or popular magazines, books, websites, audio and video recordings, etc.

For each text, the teacher helps the student develop their linguistic skills: listening, comprehension, and oral and written expression. In addition, they must use this text to identify the grammatical structures they will develop during the same class session. Here, for illustration purposes, we recall a set of grammatical structures that can be developed as examples. Of course, it is not a question of developing them all or in the same way. Some can be recalled and others in great detail.

Examples of themes	Grammatical structures
The pharmaceutical industry	The subjunctive. The conditional. The imperative.
The food industry	The past participle. The passive form.
The National Employment Agency ANEM	Possessive adjectives, possessive pronouns.
Sustainable development	Demonstratives, Demonstrative pronouns.
Renewable energies	The expression of quantity (several, a few, enough, many, more, less, as much, etc.).
Biotechnology	Numbers and measurements.
Stem cells	The pronouns "who, that, where, whose".
Road safety	Subordinate preposition of time.
The dams	The cause, The consequence.
Water – Water resources	The goal, the opposition, the condition.
Avionics	Comparatives, superlatives.
Automotive electronics	...
Electronic newspapers	
Carbon 14 dating	
Violence in stadiums	
Drugs: a social scourge	
Smoking	
School failure	
The Algerian War	
Social networks	
China, an economic power	
Superconductivity	
Cryptocurrency	
Advertising	
Autism	

Assessment method:

Review: 100%.

Bibliographic references:

1. M. Badefort, Objective: International French Test, Edulang, 2006.
2. O. Bertrand, I. Schaffner, Passing the TCF, Exercises and training activities, Les éditions de l'école polytechnique, 2009.
3. M. Boulares, J.-L. Frerot, Progressive French Grammar with 400 exercises, Advanced Level, CLE International.
4. Collective, Besherelles: Grammar for all, Hatier.
5. Collective, Besherelles: Conjugation for all, Hatier.
6. Mr. Grégoire, Progressive French Grammar with 400 exercises, Beginner Level, CLE International, 1997.
7. A. Hasni et al., Training in teaching science and technology in secondary schools, University of Quebec Press, 2006.
8. J.-L. Lebrun, Practical guide to scientific writing, EDP Sciences, 2007.
9. JM Robert, Difficulties of French, Hachette,
10. C. Tisset, Teaching the French language at school: Grammar, Spelling and Conjugation, Hachette Education, 2005.
11. J. Bossé-Andrieu, Summary of the Rules of Grammar and Spelling, University Press Quebec, 2001.
12. J.-P. Colin, French made simple, Eyrolles, 2010.
13. Collective, French Assessment Test, Hachette, 2001.
14. Y. Delatour et al., Practical French grammar in 80 cards with corrected exercises, Hachette, 2000.
15. Ch. Descotes et al., The Exerciser: French expression for the intermediate level, Presses Grenoble University, 1993.
16. H. Jaraush, C. Tufts, On the Vif, Heinle Cengage Learning, 2011.
17. J. Dubois et al., The Essentials – Spelling, Larousse, 2009.

Semester: 2

Teaching unit: UET 1.2 Subject 1:

English Language 2 VHS: 10:30

p.m. (Course: 1.5 hours)

Credits: 1

Coefficient: 1

Objective:

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

Recommended prior knowledge:

Basic English.

Contents:

The English syllabus 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 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 also contain a terminology which means the translation of some words from English to French one. , 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. 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 Liquid It is + Adjective + to As It is + Adjective or Verb + that… Similarity, Difference In Spite of, Although Formation of Adjectives Phrasal Verbs

Mode evaluation:

Exam: 100%.

References:

1. **J. Upjohn, S. Blattes, V. Jans, Minimum Competence in Scientific English, Office of University Publications, 1994.**
2. **AJ Herbert, The Structure of Technical English, Longman, 1972.**
3. **S. Berland-Delepine, Methodical grammar of modern English with exercises, 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.
Claude Renucci, English: 1000 Words and Expressions from the Press: Vocabulary and Expressions from the Economic, Social and Political World, Fernand Nathan, 2006.

Semester: 3

Teaching unit: UEF 2.1.1 Subject 1:

Mathematics 3 VHS: 67h30 (Lecture:

3h00, TD: 1h30)

Credits: 6

Coefficient: 3

Teaching objectives:

At the end of this course, the student should be able to know the different types of series and their conditions of convergence as well as the different types of convergence.

Recommended prior knowledge

Mathematics 1 and Mathematics 2

Contents of the subject:

Chapter 1: Simple and multiple integrals 1.1 **3 weeks**
Reminders on the Riemann integral and on the calculation of primitives. 1.2 Double and triple integrals.
1.3 Application to the calculation of areas, volumes, etc.

Chapter 2: Improper Integrals 2.1 **2 weeks**
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 3.1 **2 weeks**
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 5.1 Definition **3 weeks**
and properties. 5.2 Application to the resolution of differential equations.

Chapter 6: Laplace Transform 6.1 Definition **2 weeks**
and properties. 6.2 Application to the resolution of differential equations.

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1- F. Ayres Jr, Theory and Applications of Differential and Integral Calculus - 1175 corrected exercises, McGraw-Hill.

2- F. Ayres Jr, Theory and Applications of Differential Equations - 560 corrected exercises, McGraw-Hill.

3- J. Lelong-Ferrand, JM Arnaudiès, Mathematics Course - Differential Equations, Multiple Integrals, Volume 4, Dunod University.

4- M. Krasnov, Collection of problems on ordinary differential equations, Moscow Edition 5- N. Piskunov, Differential and

integral calculus, Volume 1, Moscow Edition 6- J. Quinet, Elementary course in higher

mathematics 3- Integral calculus and series, Dunod.

7- J. Quinet, Elementary course in higher mathematics 4- Differential equations, Dunod.

8- MR Spiegel, Laplace Transforms, Course and Problems, 450 Corrected Exercises, McGraw-Hill.

Semester: 3

Teaching unit: UEF 2.1.1 Subject 2:
Waves and Vibrations VHS: 45h00

(Lecture: 1h30, TD: 1h30)
Credits: 4

Coefficient: 2

Teaching objectives

Introduce the student to the phenomena of mechanical vibrations restricted to low amplitude oscillations for 1 or 2 degrees of freedom as well as to the study of the propagation of mechanical waves.

Recommended prior knowledge

Mathematics 2, Physics 1 and Physics 2

Subject content: Preamble:

This subject is divided into two parts, Waves and Vibrations, which can be approached independently of each other. In this regard, and due to the consistency of this subject in terms of content, it is recommended to approach this subject in this order: Waves and then Vibrations for students in the Electrical Engineering streams (Group A).

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 you that this subject is intended for engineering professions in the Science and Technology field. Also, the teacher is asked to skim over all parts of the course that require demonstrations or theoretical developments and to focus only on the applied aspects. Moreover, the demonstrations can be the subject of auxiliary work to be requested from the students as activities within the framework of the student's personal work. Consult in this regard the paragraph "G- Student Assessment through Continuous Assessment and Personal Work" present in this training offer.

Part A: Vibrations Chapter

1: Introduction to Lagrange's equations 1.1 Lagrange's equations for a particle 1.1.1 Lagrange's equations 1.1.2 Case of conservative systems 1.1.3 Case of velocity-dependent friction forces 1.1.4 Case of a time-dependent external force 1.2 System with several degrees of freedom. — **2 weeks**

Chapter 2: Free Oscillations of One-Degree-of-Freedom Systems 2.1 Undamped Oscillations 2.2 Free Oscillations of Damped Systems — **2 weeks**

Chapter 3: Forced Oscillations of One-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-degree-of-freedom systems 1 week
4.1 Introduction

4.2 Two-degree-of-freedom systems

Chapter 5: Forced Oscillations of Two-Degree-of-Freedom Systems 2 weeks 5.1 Lagrange Equations 5.2 Mass-Spring-Damper System 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 1.1 Generalities and basic definitions 1.2 Propagation equation **2 weeks**

1.3 Solution of the propagation equation 1.4 Progressive sinusoidal wave 1.5 Superposition of two progressive sinusoidal waves

Chapter 2: Vibrating Strings 2.1 Wave Equation 2.2 Harmonic Progressive Waves 2.3 Free Oscillations of a String of Finite Length 2.4 Reflection and Transmission **2 weeks**

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

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

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. **H. Djelouah; Vibrations and Mechanical Waves – Courses & Exercises (University of USTHB: perso.usthb.dz/~hdjelouah/Coursvom.html)**
2. **T. Becherrawy; Vibrations, waves and optics; Hermes science Lavoisier, 2010 3. J. Brac; Propagation of acoustic and elastic waves; Hermès science Publ. Lavoisier, 2003.**
4. **R. Lefort; Waves and Vibrations; Dunod, 2017 5. J. Bruneaux; Vibrations, waves; Ellipses, 2008.**
6. **J.-P. Perez, R. Carles, R. Fleckinger; Electromagnetism Foundations and Applications, Ed. Dunod, 2011.**
7. **H. Djelouah; Electromagnetism; Office of University Publications, 2011.**

Semester: 3

Teaching unit: UEF 2.1.2 Subject 1:

Fundamental electronics 1 VHS: 45h00 (Lecture: 1h30, TD: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives:

Explain the calculation, analysis, and interpretation of electronic circuits. Understand the properties, electrical models, and characteristics of electronic components: diodes, bipolar transistors, and operational amplifiers.

Recommended prior knowledge Notions of materials physics and fundamental electricity.

Content of the subject:

The number of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1. Continuous Regime and Fundamental Theorems **3 weeks**

Definitions (dipole, branch, node, mesh), voltage and current generators (ideal, real), voltage-current relationships (R, L, C), voltage divider, current divider. Fundamental theorems: superposition, Thévenin, Norton, Millmann, Kennelly, Equivalence between Thévenin and Norton, Maximum power transfer theorem.

Chapter 2. Passive Quadrupoles **3 weeks**

Representation of a passive network by a quadrupole. Quantities characterizing the behavior of a quadrupole in an assembly (input and output impedance, voltage and current gain), application to matching. Passive filters (low-pass, high-pass, etc.), Gain curve, Phase curve, Cutoff frequency, Bandwidth.

Chapter 3. Diodes **3 weeks**

Basic reminders on the physics of semiconductors: Definition of a semiconductor, Crystalline Si, Doping concepts, N and P semiconductors, PN junction, Construction and operation of a diode, direct and reverse polarizations, Current-voltage characteristic, static and variable regime, Equivalent diagram. Applications of diodes: Single and double half-wave rectification. Voltage stabilization by Zener diode. Clipping, Other types of diodes: Varicap, LED, Photodiode.

Chapter 4. Bipolar Transistors **3 weeks**

Bipolar Transistors: Transistor effect, operating modes (blocking, saturation, etc.), Static characteristics network, Polarizations, Load line, Quiescent point, etc. Study of the three fundamental assemblies: EC, BC, CC, Equivalent diagram, Voltage gain, Decibel gain, Bandwidth, Current gain, Input and output impedances. Study of multi-stage BF amplifiers in static and dynamic conditions, link capacitors, decoupling capacitors. Other uses of the transistor: Darlington assembly, switching transistor, etc.

Chapter 5 - Operational Amplifiers: Principle, **3 weeks**

Equivalent Schematic, Ideal Op-Amp, Feedback, Op-Amp Characteristics, Basic Operational Amplifier Assemblies: Inverter, Non-Inverter, Adder, Subtractor, Comparator, Follower, Differentiator, Integrator, Logarithmic, Exponential, etc.

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. **A. Malvino, Principle of Electronics, 6th Edition Dunod, 2002.**
2. **T. Floyd, Electronic Components and Application Systems, 5th Edition, Dunod, 2000.**
3. **F. Milsant, Electronics Course (and Problems), Volumes 1 to 5, Eyrolles.**
4. **M. Kaufman, Electronics: Components, Volume 1, McGraw-Hill, 1982.**
5. **P. Horowitz, Treatise on Analog and Digital Electronics, Volumes 1 and 2, Publitronic-Elektor, 1996.**
6. **M. Ouhrouche, Electrical Circuits, International Polytechnic Press, 2009.**
7. **Neffati, General Electricity, Dunod, 2004 8. D.**

Dixneuf, Principles of Electrical Circuits, Dunod, 2007 9. Y.

Hamada, Electronic Circuits, OPU, 1993.

10. I. Jelinski, All Electronics in Exercises, Vuibert, 2000.

Semester: 3

Teaching unit: UEF 2.1.2 Subject 2:

Fundamental electrical engineering 1 VHS: 45h00

(Lecture: 1h30, TD: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives: To understand

the basic principles of electrical engineering. To understand the operating principle of transformers and electrical machines.

Recommended prior knowledge: Basic electricity concepts.

Subject content: Chapter 1.

Mathematical reminders on complex numbers (CN) (1 Week)

Cartesian form, conjugate NCs, Module, Arithmetic operations on NCs (addition, etc.), Geometric representation, Trigonometric form, Moivre formula, root of NCs, Representation by an exponential of an NC, Trigonometric application of Euler's formulas, Application to electricity of NCs.

Chapter 2. Reminders on the fundamental laws of electricity (2 Weeks)

Continuous regime: electric dipole, association of R, C, L dipoles.

Harmonic regime: representation of sinusoidal quantities, average and effective values, Fresnel representation, complex notation, impedances, powers in sinusoidal regime (instantaneous, active, apparent, reactive), Boucherot's Theorem.

Transient regime: RL circuit, RC circuit, RLC circuit, charging and discharging of a capacitor.

Chapter 3. Electrical Circuits and Powers (3 Weeks)

Single-phase circuits and electrical powers. Three-phase systems: Balanced and unbalanced (symmetrical components) and electrical powers.

Chapter 4. Magnetic Circuits (3 Weeks)

Magnetic circuits in sinusoidal alternating current. Self and mutual inductance. Electrical-magnetic analogy.

Chapter 5. Transformers (3 Weeks)

Ideal single-phase transformer. Real single-phase transformer. Other transformers (isolation, pulse, autotransformer, three-phase transformers).

Chapter 6. Introduction to Electrical Machines (3 Weeks)

General information on electrical machines. Principle of operation of the generator and the motor. Power and efficiency balance.

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references: (Depending

on the availability of documentation at the establishment, websites, etc.)

1. **JP Perez, Electromagnetism Foundations and Applications, 3rd Edition, 1997.**
2. **A. Fouillé, Electrotechnics for Engineers, 10th edition, Dunod, 1980.**
3. **C. François, Electrical Engineering, Ellipses, 2004**

4. L. Lasne, Electrotechnique, Dunod,
2008 5. J. Edminister, Theory and applications of electrical circuits, McGraw Hill,
1972 6. D. Hong, Electrical circuits and measurements,
Dunod, 2009 7. M. Kostenko, Electrical Machines - Volume 1, Volume 2, Editions MIR, Moscow, 1979.
8. M. Jufer, Electromechanics, Polytechnic and University Presses of Romandie - Lausanne, 2004.
9. A. Fitzgerald, Electric Machinery, McGraw-Hill Higher Education, 2003.
10. J. Lesenne, Introduction to Advanced Electrical Engineering. Technique and Documentation, 1981.
11. P. Maye, Industrial electric motors, Dunod, 2005.
12. S. Nassar, Electric Circuits, Maxi Schaum.

Semester: 3

Teaching unit: UEM2.1 Subject 1:

Probability and statistics VHS: 45h00

(Lecture: 1h30, Tutorial: 1h30)

Credits: 4

Coefficient: 2

Subject objectives

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

Recommended prior knowledge

Mathematics 1 and Mathematics 2

Content of the material:

Part A: Statistics Chapter

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

Chapter 2: Single-variable statistical series A.2.1 **(3 weeks)**
Number, Frequency, Percentage.
A.2.2 Cumulative workforce, Cumulative frequency.
A.2.3 Graphical representations: bar chart, pie chart, stick chart.
Polygon of numbers (and frequencies). Histogram. Cumulative curves.
A.2.4 Position characteristics A.2.5
Dispersion characteristics: range, variance and standard deviation, coefficient of variation.
A.2.6 Shape characteristics.

Chapter 3: Two-variable statistical series A.3.1 Data tables **(3 weeks)**
(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 corridor and correlation ratio.
A.3.5 Functional adjustment.

Part B: Probabilities Chapter

1: Combinatorial Analysis B.1.1 Arrangements **(1 Week)**
B.1.2 Combinations
B.1.3 Permutations.

Chapter 2: Introduction to Probability B.2.1 Algebra **(2 weeks)**
of Events B.2.2 Definitions B.2.3
Probability Spaces
B.2.4 General Probability
Theorems

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

B.3.3 Bayes formula.

Chapter 4: Random Variables B.4.1 (1 Week)
Definitions and Properties,
B.4.2 Distribution Function,
B.4.3 Mathematical Expectation,
B.4.4 Covariance and moments.

Chapter 5: Common discrete and continuous probability laws (3 Weeks)
Bernoulli, binomial, Poisson, ...; Uniform, normal, exponential, ...

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. D. Dacunha-Castelle and M. Duflo. Probability and Statistics: Fixed-Time Problems. Masson, 1982.

2. J.-F. Delmas. Introduction to probability calculus and statistics. ENSTA handout, 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. Course in mathematical statistics. Economica, 1988.
7. A. Montfort. Introduction to Statistics. Ecole Polytechnique, 1991

Semester: 3

Teaching unit: UEM2.1 Subject 2:

Computer science 3 VHS: 22h30

(TP: 1h30)

Credits: 2

Coefficient: 1

Subject objectives:

Teach the student programming using easy-to-access software (mainly: Matlab, Scilab, Mapple, etc.). This subject will be a tool for carrying out practical work on numerical methods in S4.

Recommended prior knowledge:

The basics of programming acquired in computer science 1 and 2.

Content of the subject:

TP 1: Presentation of a scientific programming environment (1 Week)

(Matlab, Scilab, etc.)

TP 2: Script files and Data and variable types (2 Weeks)

TP 3: Reading, displaying and saving data (2 Weeks)

TP 4: Vectors and matrices (2 Weeks)

TP 5: Control instructions (for and while loops, if and switch instructions) (2 weeks)

TP 6: Function files (2 Weeks)

TP 7: Graphics (Management of graphics windows, plot) (2 Weeks)

TP 8: Using toolbox (2 Weeks)

Assessment method:

Continuous assessment: 100%.

Bibliographic references: 1. Jean-

Pierre Grenier, Getting started in algorithms with MATLAB and SCILAB, Ellipses, 2007.

2. Laurent Berger, Scilab from theory to practice, 2014.

3. Bégyn Arnaud, Gras Hervé, Grenier Jean-Pierre, Programming and simulation in Scilab, 2014.

4. Thierry Audibert, Amar Oussalah, Maurice Nivat, Computer Science: Programming and Calculation scientist in Python and Scilab scientific preparatory classes 1st and 2nd years, Ellipses, 2010.

Semester: 3

Teaching unit: UEM 2.1 Subject 3:

Electronics and Electrical Engineering Practical Work VHS:

22h30 (Practical Work: 1h30)

Credits: 2

Coefficient: 1

Teaching objectives:

Consolidation of knowledge acquired in fundamental electronics and electrical engineering subjects to better understand and assimilate the fundamental laws of electronics and electrical engineering.

Recommended prior knowledge: Basic electronics.

Basic electrical engineering.

Content of the subject:

The practical work teacher is required to complete at least 3 practical work in Electronics and 3 practical work in Electrical Engineering from the list of practical work proposed below:

Electronics 1 Practical Work
TP 1: Fundamental theorems TP 2:
Characteristics of passive filters TP 3:
Characteristics of the diode / rectification TP 4: Stabilized power supply with Zener diode TP 5: Characteristics of a transistor and operating point TP 6: Operational amplifiers.

Electrical Engineering Practical Work 1 Practical Work 1: Measurement of single-phase voltages and currents Practical Work 2: Measurement of three-phase voltages and currents Practical Work 3: Measurement of active and reactive power in three-phases Practical Work 4: Magnetic circuits (hysteresis cycle)
TP 5: Tests on transformers TP 6: Electrical machines (demonstration).

Assessment method:

Continuous assessment: 100%

Bibliographic references:

Semester: 3

Teaching unit: UEM 2.1 Subject 4:
Practical work on waves and vibrations

VHS: 3:00 p.m. (practical work: 1:00 p.m.)
Credits: 1

Coefficient: 1

Teaching objectives

The objectives assigned by this program focus on introducing students to putting into practice the knowledge received on the phenomena of mechanical vibrations restricted to low amplitude oscillations for one or two degrees of freedom as well as the propagation of mechanical waves.

Recommended prior knowledge

Vibrations and waves, Mathematics 2, Physics 1, Physics 2.

Content of the subject:

TP1: Mass – spring TP2:

Simple pendulum TP3:
Torsion pendulum TP4:

Oscillating electric circuit in free and forced mode TP5: Coupled
pendulums TP6: Transverse
oscillations in vibrating strings TP7: Grooved pulley according to

Hoffmann TP8: Electromechanical systems
(The electrodynamic loudspeaker)
TP9: Pohl's pendulum TP10:
Propagation of longitudinal waves in a fluid.

Note: It is recommended to choose at least 5 TPs from the 10 offered.

Assessment method:

Continuous assessment: 100%.

Bibliographic references:

Semester: 3

Teaching unit: UED 2.1 Subject 1:

State of the art of electrical engineering VHS:

22h30 (Course: 1h30)

Credits: 1

Coefficient: 1

Teaching objectives

To give the student a general overview of the different existing fields in Electrical Engineering while highlighting the impact of electricity in improving human daily life.

Recommended prior knowledge

None

Content of the subject:

1- The Electrical Engineering family: Electronics, Electrotechnics, Automation, Telecommunications, etc.

2- Impact of Electrical Engineering on the development of society: Advances in Microelectronics, Automation and supervision, Robotics, Development of telecommunications, Instrumentation in the development of health, etc.

Assessment method: Final exam: 100%.

Bibliographic references: (Depending

on the availability of documentation at the establishment, websites, etc.)

Semester: 3

Teaching unit: UED 2.1 Subject 2:

Energy and environment VHS: 10:30 p.m.

(Course: 1:30 p.m.)

Credits: 1

Coefficient: 1

Teaching objectives: To introduce the

student to the different existing energies, their sources and the impact of their uses on the environment.

Recommended prior knowledge:

Concepts of energy and environment.

Content of the subject:

Chapter 1: Different Energy Resources

Chapter 2: Energy Storage

Chapter 3: Consumption, reserves and developments in energy resources

Chapter 4: The different types of pollution

Chapter 5: Detection and treatment of pollutants and waste

Chapter 6: Impact of pollution on health and the environment.

Assessment method:

Final exam: 100%.

Bibliographic references: 1-

Jenkins et al., Electrotechnics of renewable energies and cogeneration, Dunod, 2008 2-
Pinard, Renewable energies for electricity production, Dunod, 2009 3-
Crastan, Power plants and alternative electricity production, Lavoisier, 2009 4-
Labouret and Villoz, Photovoltaic solar energy, 4th ed., Dunod, 2009-10.

Semester: 3

Teaching unit: UET 2.1 Subject 1:

Technical English VHS: 22h30

(Course: 1h30)

Credits: 1

Coefficient: 1

Teaching objectives:

This course should enable the student to acquire a sufficiently significant level of language to enable him to use a scientific document and speak about his specialty and his field in English, at least, with a certain ease and clarity.

Recommended prior knowledge:

English 1 and English 2

Content of the subject:

- Oral comprehension and oral expression, vocabulary acquisition, grammar, etc.

- Nouns and adjectives, comparatives, following and giving instructions, identifying things.

- Use of numbers, symbols, equations.

- Measurements: Length, area, volume, power, etc.

- Describe scientific experiments.

- Characteristics of scientific texts.

Assessment method:

Final exam: 100%.

Bibliographic references:

1. **J. Upjohn, S. Blattes, V. Jans, Minimum Competence in Scientific English, Office of University Publications, 1994.**
2. **AJ Herbert, The Structure of Technical English, Longman, 1972.**
3. **Test of English as a Foreign Language – Preparation Guide, Cliffs, 1991.**
4. **Cambridge – First Certificate in English, Cambridge books, 2008.**
5. **K. Wilson, Th. Healy, First Choice, Oxford, 2007.**
6. **M. Mann, S. Tayore-Knowles, Destination: Grammar & Vocabulary with Answer Key, MacMillan, 2006.**
7. **P. Charles Brown, Norma D. Mullen, English for Computer Science, Oxford University Press, 1989.**
8. **Graeme Kennedy, Structure and Meaning in English: A Guide for Teachers, Pearson, 2004.**
9. **Anne M. Hanson, Brain-Friendly Strategies for Developing Student Writing Skills, 2nd Edition, Corwin Press, 2008.**
10. **Ann Bridges, How to Pass Higher English, Hodder Gibson-Hachette, 2009.**

Semester: 4

Teaching unit: UEF 2.2.1 Subject 1:

Physical quantity sensors VHS: 67h30 (Lecture: 3h00,

TD: 1h30)

Credits: 6

Coefficient: 3

Teaching objectives: This subject

is mainly intended for the detailed study of the different families of sensors used in the biomedical field and the study of the associated conditioning system. At the end of this subject, the student will be able to define the different types of biomedical sensors, solve sensor conditioning problems, explain the operating principle of sensors dedicated to biomedical applications.

Recommended prior knowledge Basic notions of

electricity and electronics.

Content of the subject:

The number of weeks displayed is for informational purposes only. The course leader is not required to strictly adhere to this size or the arrangement of the chapters.

Chapter 1: Fundamental concepts of physiological quantity detection and measurement 2 weeks

Chapter 2: Resistive Sensors and Biomedical Applications **2 weeks**
Thermistor, Strain gauge (metallic, electrolytic, mercury), Magnetoresistive (Hall effect), Photoresistors

Chapter 3: Inductive sensors and biomedical applications **1 week**
Mutual inductance (linear variable differential transformer LVDT and rotational variable differential transformer) RVDT)

Chapter 4: Capacitive Sensors and Biomedical Applications **1 week**
Capacitance measurement circuits, Biological capacities

Chapter 5: Photoelectric Sensors and Biomedical Applications **2 weeks**
Photoemission tubes, Photovoltaic cells, Light-emitting diodes, Phototransistor

Chapter 6: Piezoelectric Sensors and Biomedical Applications **2 weeks**
Ultrasound and its applications

Chapter 7: Thermoelectric Sensors and Biomedical Applications **2 weeks**
Thermoelectricity: the Peltier effect

Chapter 8: Chemical Sensors and Biomedical Applications 2 weeks
Dalton's law, Henry's law, measuring electrodes, fiber optic chemical meters, specific ion electrodes, specific ion field effect transistor,

Chapter 9: Electrodes and Microelectrodes **1 week**

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. G, Asch, Sensors in industrial instrumentation, Dunod Edition.
2. Dassonvalle, Sensors: Exercises and corrected problems, Dunod Edition.
3. E. Altman, A. Ferreira and J. Galtier, Satellite Telecommunications Networks: Technology and Services, Dunod, Paris, 1999.
4. PG Fontolliet, Telecommunications Systems, Electricity Treaty, Vol. XVIII, PPUR, Lausanne, 1999 (Chapters 12 & 13).
5. C. Servin, Networks & Telecoms, 2nd ed., Dunod, Paris, 2006.
6. G. Baudoin, Digital Radiocommunications T1: Principles, Modeling and Simulation, Dunod, Paris, 2007.

Semester: 4

Teaching unit: UEF 2.2.1 Subject 2:

Combinatorial and sequential logic VHS: 45h00 (Lecture: 1h30, TD: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives:

Understand common combinational circuits. Know how to design some applications of combinational circuits using standard tools such as truth tables and Karnaugh tables. Introduce sequential circuits through flip-flop circuits, counters and registers.

Recommended prior knowledge None.

Subject content: The number

of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1: Boolean Algebra and Simplification of Logical Functions **2 weeks**

Variables and Logical Functions (OR, AND, NOR, NAND, XOR). Laws of Boolean Algebra. De Morgan's Theorem. Complete and Incomplete Logical Functions. Representation of Logical Functions: Truth Tables, Karnaugh Tables. Simplification of Logical Functions: Algebraic Method, Karnaugh Method.

Chapter 2: Numbering Systems and Information Coding **2 weeks**

Representation of a number by codes (binary, hexadecimal, DCB, signed and unsigned binary, etc.), base change or conversion, unweighted codes (Gray code, error detection and correction codes, ASCII code, etc.), arithmetic operations in binary code.

Chapter 3: Combinational Transcoder Circuits **2 weeks**

Definitions, Decoders, Priority Encoders, Transcoders, Cascading, Applications, Analysis of the Datasheet of a Decoder Integrated Circuit, List of Decoder Integrated Circuits.

Chapter 4: Combinational Switching Circuits **2 weeks**

Definitions, Multiplexers, Demultiplexers, Cascading, Applications, Analysis of the technical data sheet of a switching integrated circuit, List of integrated circuits.

Chapter 5: Combinational Comparison Circuits **2 weeks**

Definitions, 1-bit, 2-bit and 4-bit comparison circuit, Cascading, Applications, Analysis of the datasheet of a comparison integrated circuit, List of integrated circuits.

Chapter 6: Flip-Flops **2 weeks**

Introduction to sequential circuits. The RS flip-flop, the RST flip-flop, the D flip-flop, the master-slave flip-flop, the T flip-flop, the JK flip-flop. Examples of flip-flop applications: Frequency divider by n, Pulse train generator, etc.
It is advisable to present for each flip-flop the truth table, examples of timing diagrams as well as the limits and imperfections.

Chapter 7: Counters **2 weeks**

Definition, Classification of counters (synchronous, regular, irregular, asynchronous, complete and incomplete cycles). Construction of complete and incomplete synchronous binary counters, Excitation tables for JK, D and RS flip-flops, Construction of asynchronous binary counters modulo (n).

complete, incomplete, regular and irregular. Programmable counters (start from any state).

Chapter 8. Registers **1 Week**

Introduction, classic registers, shift registers, loading and retrieving data in a register (PIPO, PISO, SIPO, SISO), shifting data in a register, a general-purpose register, the 74LS194A, available integrated circuits, Applications: classic registers, special counters, queues.

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1- J. Letocha, Introduction to Logic Circuits, McGraw Hill Edition.
2- JC Lafont, Course and problems in digital electronics, 124 exercises with solutions, Ellipses.
3- R. Delsol, Digital Electronics, Volumes 1 and 2, Edition Berti
4- P. Cabanis, Digital Electronics, Edition Dunod.
5- M. Gindre, Combinatorial Logic, Edition Ediscience.
6- H. Curry, Combinatory Logic II. North-Holland, 1972
7- R. Katz, Contemporary Logic Design, 2nd ed. Prentice Hall, 2005.
8- M. Gindre, Digital Electronics: Combinatorial Logic and Technology, McGraw Hill, 1987 9-
C. Brie, Combinatorial and Sequential Logic, Ellipses, 2002.
10- JP. Ginisti, Combinatorial Logic, Paris, PUF (coll. “What do I know?” n°3205), 1997.
11- JL. Krivine, Lambda-calculus, types and models, Masson, 1990, chap. Combinatorial logic, English translation available on the author's website.

Semester: 4

Teaching unit: UEF 2.2.2 Subject 1:

Digital methods VHS: 45h00 (Lecture:

1h30, TD: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives: Familiarization

with numerical methods and their applications in the field of mathematical calculations.

Recommended prior knowledge:

Mathematics 1, Mathematics 2, Computer Science 1 and Computer Science 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. Newton-Raphson method.

Chapter 2. Polynomial Interpolation 1. (2 Weeks)

General Introduction, 2. Lagrange Polynomial, 3. Newton Polynomials.

Chapter 3. Function Approximation: (2 Weeks)

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

Chapter 4. Digital Integration (2 Weeks)

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

Chapter 5. Solving Ordinary Differential Equations (Initial Condition or Cauchy Problem) (2 Weeks)

1. General Introduction, 2. Euler's Method, 3. Improved Euler's Method, 4. Runge's Method-Kutta.

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

1. Introduction and definitions, 2. Gaussian method and pivoting, 3. LU factorization method, 4. Choeleski factorization method MMt , 5. Thomas algorithm (TDMA) for diagonal sorting systems.

Chapter 7. Approximate Solution Method for Systems of Linear Equations (2 Weeks)

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

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. C. Brezinski, Introduction to the practice of numerical calculation, Dunod, Paris 1988.

2. G. Allaire and SM Kaber, Numerical Linear Algebra, Ellipses, 2002.

3. G. Allaire and SM Kaber, Introduction to Scilab. Corrected practical exercises in linear algebra, Ellipses, 2002.
4. G. Christol, A. Cot and C.-M. Marle, Differential Calculus, Ellipses, 1996.
5. M. Crouzeix and A.-L. Mignot, Numerical Analysis of Differential Equations, Masson, 1983.
6. S. Delabrière and M. Postel, Approximation Methods. Differential Equations. Scilab Applications, Ellipses, 2004.
7. J.-P. Demailly, Numerical Analysis and Differential Equations. Grenoble University Press, 1996.
8. E. Hairer, SP Norsett and G. Wanner, Solving Ordinary Differential Equations, Springer, 1993.
9. PG Ciarlet, Introduction to matrix numerical analysis and optimization, Masson, Paris, 1982.

Semester: 4

Teaching unit: UEF 2.2.2 Subject 2: VHS

signal theory: 45h00 (Lecture:

1h30, TD: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives:

Acquire basic notions of the mathematical tools used in signal processing.

Recommended prior knowledge:

Basic math course.

Contents of the subject:

Chapter 1. General information on signals (3 Weeks)

Objectives of signal processing. Areas of use. Classification of signals (morphological, spectral, etc.). Deterministic signals (periodic and non-periodic) and random signals (stationary and non-stationary). Causality. Notions of power and energy. Basic functions in signal processing (measurement, filtering, smoothing, modulation, detection, etc.). Examples of basic signals (rectangular pulse, triangular pulse, ramp, step, sign, Dirac, etc.)

Chapter 2. Fourier Analysis (4 Weeks)

Introduction, Mathematical reminders (scalar product, Euclidean distance, linear combination, orthogonal basis, etc.). Approximation of signals by a linear combination of orthogonal functions. Fourier series, Fourier transform, Properties. Parseval's theorem. Fourier spectrum of periodic (discrete spectrum) and non-periodic (continuous spectrum) signals.

Chapter 3. Laplace Transform (3 Weeks)

Definition. Properties of the Laplace Transform. Signal/system relationship. Application to linear and translation-invariant systems or SLIT (Time and Frequency Analysis).

Chapter 4. Convolution Product (2 Weeks)

Formulation of the convolution product, Properties of the convolution product, Convolution product and Dirac momentum.

Chapter 5. Signal Correlation Signals (3 weeks)

with finite total energy. Signals with finite total average power. Cross-correlation between signals, Autocorrelation, Properties of the correlation function. Energy spectral density and power spectral density. Wiener-Khintchine theorem. Case of periodic signals.

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. S. Haykin, "Signals and systems", John Wiley & Sons, 2nd ed., 2003.
2. AV Oppenheim, "Signals and systems", Prentice-Hall, 2004.
3. F. de Coulon, "Theory and processing of signals", Edition PPUR.
4. F. Cottet, "Signal processing and data acquisition, Course and solved exercises", Dunod.
5. B. Picinbono, "Signal and Systems Theory with Solved Problems", Bordas Edition.
6. M. Benidir, "Signal Theory and Processing, Volume 1: Representation of Signals and Systems - Course and Corrected Exercises", Dunod, 2004.
7. M. Benidir, "Signal Theory and Processing, Volume 2: Basic Methods for Signal Analysis and Processing - Course and Corrected Exercises", Dunod, 2004.
8. J. Max, Signal Processing

Semester: 4

Teaching unit: UEM 2.2 Subject 1:

Electrical and electronic measurements VHS: 37h30

(Lecture: 1h30, Practical work: 1h00)

Credits: 3

Coefficient: 2

Teaching objectives:

Introduce the student to the techniques of measuring electrical and electronic quantities. Familiarize them with the use of analog and digital measuring devices.

Recommended prior knowledge: General Electricity, Fundamental Laws of Physics.

Subject content: The number

of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1. Measurements, quantities and uncertainties **5 weeks**

Introduction, Quantity, Standard, Unit systems, Table of multiples and submultiples, Dimensional equations, Useful formulas, Measurement precision, Measurement error, Classification of errors, Uncertainties in indirect measurements, Qualities of measuring devices, Calibration of measuring devices, Graphic symbols of measuring devices, General measurement methods (Deviation, zero, resonance methods), Application exercises.

Chapter 2. Measurement Methods **6 weeks**

1. Voltage Measurements: Direct Voltage Measurement Methods, Alternating Voltage Measurements, Indirect Voltage Measurement Method by the Opposition Method.

2. Current measurement: Direct method of current measurement, Use of simple Shunt.

3. Resistance measurements: Classification of resistances, Voltammetric method, Zero method: The Wheatstone Bridge, Measurement of very large resistances by the charge loss method.

4. Impedance measurements: Capacitance measurements, Inductance measurements, AC bridges.

5. Continuous Power Measurements: Fundamental Relationship, Ammeter and Voltmeter Method, Continuous Electrodynamic Wattmeter.

6. AC Power Measurements: Instantaneous and average power, Complex power, apparent power, active power and reactive power, Electrodynamic AC Wattmeter, 3 voltmeter method for active power, Direct reactive power measurement method, Indirect reactive power measurement method

7. Phase shift measurements: Direct measurement of phase shifts using an oscilloscope, Measurement of phase shifts using Lissajous figures.

8. Frequency and period measurements: Direct frequency measurement with an oscilloscope, Frequency measurement with Lissajous figures, Frequency measurement using the frequency meter method, Frequency measurement using the period meter method, Application exercises.

Chapter 3. Measuring Devices Introduction Analog **4 weeks**

measuring devices: Classification of deflection devices, The moving coil galvanometer, Structure of the magnetoelectric ammeter, Structure of the magnetoelectric voltmeter, Operation of the electrodynamic wattmeter in alternating current Digital measuring devices: Analog-to-digital converters (ADC), Operating principle of a digital measuring device, Examples of digital measuring devices (Multimeter, Oscilloscope, etc.).

Electrical and electronic measurements:

TP No. 1: Resistance measurement:

Measure resistance using the following 5 methods: voltammetric, ohmmeter, Wheatstone bridge, comparison and substitution.
Compare these methods with each other and establish an error calculation.

TP No. 2: Inductance measurement:

Carry out the measurement of inductances using the following 3 methods: voltammetric, Maxwell bridge, resonance.
Compare these methods with each other and establish an error calculation.

TP No. 3: Capacity measurement:

Carry out capacity measurements using the following 3 methods: voltammetric, Sauty bridge, resonance.

Compare these methods with each other and establish an error calculation.

TP No. 4: Phase shift

measurement: Measure the resistances using the following 2 methods: Phase meter and oscilloscope.

TP No. 5: Single-phase power measurement:

Measure the resistance using the following 5 methods: wattmeter, Cosÿmeter, three voltmeters, three ammeters, power sensor.
Compare these methods with each other and establish an error calculation.

TP No. 6: Three-phase power measurement:

Carry out resistance measurements using the following methods: Star system and delta system, balanced and unbalanced.

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1- M. Cerr, Industrial Instrumentation: T.1, Tec and Doc Edition.
2- M. Cerr, Industrial Instrumentation: T.2, Tec and Doc Edition.
3- P. Oguic, Measurements and PC, ETSF Edition.
4- D. Hong, Electrical Circuits and Measurements, Dunod, 2009.
5- W. Bolton, Electrical and Electronic Measurement and Testing, 1992.
6- A. Fabre, Electrical and electronic measurements, OPU, 1996.
7- G. Asch, Sensors in industrial instrumentation, Dunod edition, 2010.
8- L. Thompson, Electrical Measurements and Calibration: Fundamentals and Applications, Instrument Society of America, 1994.
9- JP Bentley, Principles of Measurement Systems, Pearson Education, 2005.
10- J. Niard, Electrical measurements, Nathan, 1981.
11- P. Beauvilain, Electrical and Electronic Measurements.
12- M. Abati, Applied electronic measurements, Delagrave Techniques and Standardization Collection.
13- P. Jacobs, Electrical Measurements, Dunod Edition.
14- A. Leconte, Measurements in electrotechnics (Document D 1 501), The engineering techniques.

Internet sources:

- **http://sitelec.free.fr/cours2htm**
- **http://perso.orange.fr/xcotton/electron/coursetdocs.ht**
- **http://eunomie.u-bourgogne.fr/elearning/physique.html**
- **http://www.technique-ingenieur.fr/dossier/entreprisesdemesure**

Semester: 4

Teaching unit: UEM 2.2 Subject 2:

Practical work on physical quantity sensors VHS: 10:30

p.m. (practical work: 1:30 p.m.)

Credits: 2

Coefficient: 1

Teaching objectives: This subject
is mainly intended for the detailed study of the different families of sensors used in the biomedical field and the study of the associated conditioning system.

Recommended prior knowledge Basic notions of
electricity and electronics.

Content of the subject:

TP n° 1: Resistive sensors and biomedical applications
- **Strain gauge (metallic, electrolytic, mercury)**
- **Magnetoresistive (Hall effect)**

TP n° 2: Photoelectric sensors
- **Photoresistors**
- **Photodiodes**
- **Phototransistor**

TP n° 3: Piezoelectric sensors
- **Ultrasound and its applications**

TP n° 4: Thermoelectric sensors
- **Thermocouple**
- **Thermistor**

Depending on the availability of teaching materials, it is recommended to carry out at least 1 practical exercise of each manipulation.

Assessment method:
Continuous assessment: 100%.

Bibliographic references:
- **G. Asch, Sensors in industrial instrumentation, Dunod Edition.**
- **Dassonvalle, Sensors: Exercises and corrected problems, Dunod Edition.**

Semester: 4

Teaching unit: UEM 2.2 Subject 3:

Practical work Combinatorial and sequential logic VHS:

10:30 p.m. (Practical work: 1:30 p.m.)

Credits: 2

Coefficient: 1

Teaching objectives:

Consolidate the knowledge acquired during the course of the subject "Combinatory and Sequential Logic" through practical work to better understand and assimilate the content of this subject.

Recommended prior knowledge: Combinatorial and Sequential Logic.

Subject content: The teacher

chooses from this list of practical work between 4 and 6 practical work to be carried out and covering the two types of logic circuits (combinatory and sequential).

TP1: TTL and CMOS integrated circuit technology.
Understand and test the different logic gates

TP2: Simplification of logical equations through practice
Discover the rules for simplifying equations in Boolean algebra through practice

TP3: Study and implementation of common combinational logic functions
Example: switching circuits (MUX, DMUX), coding and decoding circuits, etc.

TP4: Study and creation of an arithmetic combinational circuit Creation of an adder and/or subtractor circuit for 2 4-bit binary numbers.

TP5: Study and creation of a combinational logic circuit Creation of a logic function using logic gates. Example: a 7-segment display and/or a generator of the 2's complement of a 4-bit number and/or a generator of the 4-bit Gray code, etc.

TP6: Study and creation of a combinational logic circuit Complete study (Truth table, Simplification, Logic diagram, Practical assembly and Tests) of a combinational circuit based on specifications.

TP7: Study and creation of meter circuits
Incomplete asynchronous counter circuits using flip-flops, Irregular cycle synchronous counter circuits using flip-flops

TP8: Study and creation of registers

Assessment method:

Continuous assessment: 100%

Bibliographic references:

1. J. Letocha, Introduction to Logic Circuits, Mc-Graw Hill Edition.
2. JC Lafont, Course and problems in digital electronics, 124 exercises with solutions, Edition Ellipses.

Semester: 4

Teaching unit: UEM 2.2 Subject 4:

Digital Methods Practical Work VHS: 22h30

(Practical work: 1h30)

Credits: 2

Coefficient: 1

Teaching objectives:

Programming of different numerical methods with a view to their applications in the field of mathematical calculations using a scientific programming language (Matlab, Scilab, etc.).

Recommended prior knowledge: Numerical Method,

Computer Science 2 and Computer Science 3.

Subject Content: Chapter 1:

Solving Nonlinear Equations 1. Bisection Method. 2. Fixed Point Method, 3. Newton-Raphson Method — **3 weeks**

Chapter 2: Interpolation and Approximation — **3 weeks**

1. Newton's Interpolation, 2. Chebyshev's Approximation

Chapter 3: Numerical Integrations 1. Rectangle Method, 2. Trapezoid Method, 3. Simpson Method — **3 weeks**

Chapter 4: Differential Equations 1. Euler's Method, 2. Runge-Kutta Methods — **2 weeks**

Chapter 5: Systems of Linear Equations 1. — **4 weeks**

Gauss-Jordon Method, 2. Crout Decomposition and LU Factorization, 3. Jacobi Method, 4. Gauss-Seidel method

Assessment method:

Continuous assessment: 100%.

Bibliographic references:

1. **José Ouin, Algorithmics and numerical calculation: Solved practical work and programming with Scilab and Python software, Ellipses, 2013.**
2. **Bouchaib Radi, Abdelkhalak El Hami, Mathematics with Scilab: guide to calculation, programming, graphic representations; conforms to the new MPSI program, Ellipses, 2015.**
3. **Jean-Philippe Grivet, Applied Numerical Methods: for Scientists and Engineers, EDP sciences, 2009.**

Semester: 4

Teaching unit: UED 2.2 Subject 1:

Anatomy and Physiology VHS: 10:30 p.m.

(Course: 1:30 p.m.)

Credits: 1

Coefficient: 1

Teaching objectives:

This course aims to conduct experimental and modeling studies of bioelectrical, cardiac, and muscular phenomena. Understand how the human body works to better understand the function of the equipment used in hospitals and maintained by the technician.

Recommended prior knowledge General information

on Anatomy, Physiology and Histology.

Content of the subject:

Part 1: Anatomy

General organization of the human body, Locomotor system, Circulatory system, Nervous system, Digestive system, Urinary system, Sense organs, Reproduction

Part 2: Physiology

Concepts of bioelectricity, Membrane transport, Cell potential and conduction, Conductive volumes and tissue impedance, Synaptic transmission, Biomagnetism, Electrocardiogram ECG, Electroencephalogram EEG, Electromyogram EMG, Electroretinogram ERG.

Assessment method:

Final exam: 100%.

Bibliographic references:

1. Geddes, Principles of Applied Biomedical Instrumentation, John Wiley
Edition 2. Great References in Medicine, Library of Medicine.

Semester: 4

Teaching unit: UED 2.2 Subject 2:

Medical imaging VHS: 22h30

(Course: 1h30)

Credits: 1

Coefficient: 1

Teaching objectives:

Learning the physical foundations of Nuclear Magnetic Resonance. Fundamentals of Physical Acoustics. Awareness of tissue-ultrasound interaction. Scientific foundations for subsequent courses in ultrasound imaging.

Recommended prior knowledge

Knowledge acquired in physics (ST)

Subject Content: Chapter 1:

Principles of X-Rays
Applications of X-rays, Conventional Radiology, CT or Scanner.

Chapter 2: Principles of Ultrasound
Applications: Ultrasound, Doppler effect

Chapter 3: Nuclear magnetism: microscopic and macroscopic aspects
The NMR phenomenon: classical and quantum aspects, Nuclear magnetic relaxation mechanisms, Application: MRI.

Chapter 4: Nuclear Medicine
Principle of nuclear medicine: Gamma radiation, Gamma camera, Single-photon emission computed tomography (SPECT), Positron emission tomography (PET).
Instrumentation and methods: Radiochemistry for PET, tracer synthesis, isotope production, labeling process, quality control
Principle of PET detection, PET vs. SPECT, image formation, reconstruction methods, specific treatments, software dedicated to PET image analysis Use of
PET in clinical practice: oncology, neurology, cardiology, and radiotherapy.

Assessment method:

Final exam: 100%.

Bibliographic references:

Semester: 4

Teaching unit: UET 2.2 Subject 1:

Expression and communication techniques VHS: 22h30 (Course: 1h30)

Credits: 1

Coefficient: 1

Teaching objectives:

This teaching aims to develop the student's skills, on a personal or professional level, in the field of communication and expression techniques.

Recommended prior knowledge

Languages (Arabic; French; English)

Subject content: The number

of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1: Research, analyze and organize information Identify **3 weeks**
and use locations, tools and documentary resources, Understand and analyze documents, Create and update documentation.

Chapter 2: Improving the ability to express oneself **3 weeks**
Take into account the communication situation, Produce a written message, Communicate orally, Produce a visual and audiovisual message.

Chapter 3: Improving communication skills in interaction situations
3 weeks

Analyze the interpersonal communication process, Improve face-to-face communication ability, Improve group communication ability.

Chapter 4: Developing autonomy, organizational and communication skills within the framework of a project approach Positioning **6 weeks**
oneself in a project and communication approach, Anticipating action, Implementing a project: Presentation of a report on practical work (Homework).

Assessment method:

Final exam: 100%.

Bibliographic references:

1- Jean-Denis Commeignes 12 methods of written and oral communication, 4th ed., Dunod 2013.
2- Denis Baril, Techniques of written and oral expression, Sirey, 2008.
3- M. Dubost Improving your written and oral expression: all the keys, Ellipses Edition 2014.

Semester: 5

Teaching unit: UEF 3.1.1 Subject 1:

Continuous servocontrol and VHS regulation: 67h30 (Lecture: 3h00; Tutorial: 1h30)

Credits: 6

Coefficient: 3

Teaching objectives:

To give students a good knowledge of classical methods for studying control loops, modeling a physical process, analyzing open and closed loop performance as well as synthesizing correctors.

Recommended prior knowledge: Fundamental Electronics 1, Maths 1, 2 and 3.

Subject content: The number of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1. Introduction to servocontrols History, interests, the notion of Open Loop (OL) and Closed Loop (CL) systems, servocontrols, the general representation of a servocontrol, regulators and tracking systems, what is feedback and what are its effects on systems (total gain, stability, external and internal disturbances, sensitivity, etc.), examples of real servocontrols. (2 Weeks)

Chapter 2. Reminders on the Laplace Transform (1 Week)

Chapter 3. Modeling of linear servo systems Mathematical models: Differential equations, recurrent equations, system of state equations, impulse response, poles and zeros, frequency responses (modeling electrical, mechanical (translational and rotational), thermal, fluidic, and mixed systems, explaining the properties: linearity, stationarity (invariance), causality, stability; The transfer function, functional diagrams and algebras of functional diagrams. (2 Weeks)

Chapter 4. Performance of linear systems Time analysis of 1st and 2nd order systems, time performance: rise time, response time, time constant, overshoot, settling time, frequency analysis, Bode, Nyquist and Black diagrams (gain and phase margins). (3 Weeks)

Chapter 5. Stability Introduction, definition, explanation, Routh criterion, Routh table, examples of stability assessment, special cases, examples. (2 Weeks)

Chapter 6. The Accuracy of a Servo-Controlled System Dynamic accuracy, static accuracy, expression of static error, steady-state error, class or type of servo (classes 0, 1 and 2), calculation of errors corresponding to canonical inputs, position, tracking and acceleration errors, summary table and conclusions, the stability-accuracy dilemma, rejection of disturbances, summary table and conclusions. (1 Week)

Chapter 7. Root Places Introduction, method of constructing the root place, principle of the method (Practical rules for constructing and operating the root place, Examples), rules for constructing the place (2 weeks)

(Conditions of angles and modules, Number of branches, Axis of symmetry, Starting and ending points, Asymptotic directions, parts of the real axis belonging to the locus, branch points, Other properties of the root locus), application of the method on some examples (Use of MATLAB software for plotting the root locus, application to stability assessment and compensation).

Chapter 8. Examples of synthesis projects (2 weeks)
Synthesis of phase-advance or phase-lag correctors, synthesis of regulators (Proportional, Integral and Derivative actions), showing their influence on responses and improvement of system performance.

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

Bibliographic references:

1. **M. Rivoire, "Automation Course, Volume 1: Signals and Systems", Chihab Edition.**
2. **M. Rivoire, "Automation Course, Volume 2: Analog Servo-Regulation-Control", Chihab Edition.**
3. **K. Ogata, "Automatic Control Engineering", Prentice Hall, fifth edition, 2010.**
4. **BC Kuo, "Automatic Control Systems", Prentice Hall, ninth edition, 2009.**
5. **J. Di Stefano, "Controlled Systems: Courses and Problems," McGraw Hill Edition.**
6. **JM Allenbach, "Servo-controlled systems volume 1", Geneva School of Engineering, 2005 edition.**
7. **Brizeux, "Introduction to the correction of servo-controlled systems", PSI, 2010.**
8. **Ph. Mullhaupt, "Introduction to the control of dynamic systems", Swiss Federal Institute of Technology in Lausanne, 2016.**

Semester: 5

Teaching unit: UEF 3.1.1 Subject 2:

General electronics VHS: 45h00

(Lecture: 1h30; TD: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives:

To be able to develop the calculation and analysis of different assemblies based on transistors and operational amplifiers. To be able to implement the basic functions of analog electronics using discrete components. Introduction to power electronics.

Recommended prior knowledge: Fundamental

Electronics 1.

Content of the material:

The number of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1. Applications of bipolar transistors Study of class A amplifiers, (2 Weeks)
study of multi-stage BF and small signal amplifiers, switching transistor.

Chapter 2. Field Effect Transistors (3 Weeks)
Description, Field Effect (JFET/MOSFET), Operating Principle, Polarization, Operating Regimes, Characteristic Networks, Quiescent Point, Static Charge Line, Common Source, Common Drain and Common Gate Amplifiers.

Chapter 3: Power Amplifiers Definitions, (3 weeks)
Dynamic Load Line, Output Signal Dynamics, Efficiency, Class A Power Amplifiers, Class B Power Amplifiers, Push-Pull Amplifiers, Class C Power Amplifiers.

Chapter 4: Differential amplifiers Definition, (3 weeks)
interest of differential assembly, MOSFET differential amplifier, bipolar transistor differential amplifier.

Chapter 5. Applications of operational amplifiers Principle, (4 Weeks)
Equivalent diagram, ideal op-amp, feedback, Characteristics of the op-amp, applications of operational amplifiers: oscillator, electrical filtering, Signal generation, sampling, Analog/Digital and Digital-Analog conversion.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. **A. Malvino. "Principle of Electronics", 6th Edition, Dunod, 2002.**
2. **T. Floyd. "Electronic Components and Application Systems", 5th Edition. Dunod, 2000.**
3. **F. Milsant. "Electronics Course", Volumes 1 to 5, Eyrolles.**
4. **M. Kaufman. "Electronics: Components," Volume 1, McGraw-Hill, 1982.**

5. M. Ouhrouche. "Electrical Circuits", International Polytechnic Press, 2009.
6. T. Neffati. "General Electricity", Dunod, 2004
7. D. Dixneuf. "Principles of Electrical Circuits", Dunod, 2007
8. Y. Hamada. "Electronic Circuits", OPU, 1993.
9. I. Jelinski. "All Electronics in Exercises", Vuibert, 2000.
10. M. Girard. “Discrete Active Components”, Volume 1, Hermès edition.
11. M. Girard. "Discrete Active Components, Volume 2, Field Effect Transistors", Hermès edition, 2003.
12. J. Millman. "Microelectronics", Ediscience.
13. M. Dubois. "Basic Electronic Components", Université Laval, 2006.
14. Rochette, “The fundamentals of electronics” Ellipses Marketing, 2006.

Semester: 5

Teaching unit: UEF 3.1.2 Subject 1: VHS

signal processing: 45 hours (Lecture:

1.5 hours; Tutorial: 1.5 hours)

Credits: 4

Coefficient: 2

Teaching objectives:

To familiarize the student with digital signal processing techniques such as spectral analysis and digital filtering.

Recommended prior knowledge Signal theory,

Mathematics 3, Fundamental electronics 1, Probability and statistics.

Subject content: The number

of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1. Reminders of the main results of Signal Theory Signals. (1 Week)
Fourier series. Fourier transform and conditions of existence. Parseval's theorem. Plancherel's theorem. Convolution and correlation.

Chapter 2. Random Processes (4 Weeks)
Notions on random variables (discrete and continuous, probability density, mathematical expectation, variance, standard deviation, etc.), Characteristics of random processes: mean, autocorrelation functions, inter-correlation, stationarity in the broad and strict sense, ergodism, power spectral density. Particular processes (Gaussian process, Poisson process, telegraph signal, pseudo-random sequences). Noises (thermal noise, shot noise, etc.)

Chapter 3. Analysis and synthesis of analog filters. (3 Weeks)
Reminders on the Laplace transform. Time and frequency analysis of analog filters. Poles, Zeros, P-Plane and Stability of Analog Filters. Passive and Active Filters, First and Second Order Low-Pass Filters, First and Second Order High-Pass Filters, Band-Pass Filters. Other Analog Filters (Butterworth, Chebyshev I and II, Elliptical, etc.)

Chapter 4. Signal Sampling Sampling: (3 Weeks)
Principles and definition (theoretical, averaging, blocking, etc.). Anti-aliasing filter. Shannon Condition. Analog Signal Restitution and Interpolation Filter. Quantizations, Quantization Noise. Examples of Analog-to-Digital Conversion and Digital-to-Analog Conversion.

Chapter 5. Discrete Transforms (4 Weeks)
Definition of TFTD (Discrete Time Fourier Transform), TFD (Discrete Fourier Transform), Inverse TFD, Relationship between Fourier Transform and TFD, Weighting Windows, Properties of TFD and Circular Convolution, Fast TFD Algorithms (FFT). Z Transform and Introduction to Digital Filtering (Interest, Time Equations, Transfer Function, Classification, Realization Structures, etc.).

Assessment method:

Continuous assessment: 40%; Final exam: 60%.

Bibliographic references:

1. S. Haykin, “Signals and systems”, John Wiley & Sons, 2nd ed., 2003.
2. AV Oppenheim, “Signals and systems”, Prentice-Hall, 2004.
3. F. de Coulon, “Theory and processing of signals”, Edition Presses Polytechniques Universités Romands.
4. F. Cottet, “Signal processing and data acquisition, Course and solved exercises”, Dunod.
5. B. Picinbono, “Signal and Systems Theory with Solved Problems”, Bordas Edition.
6. M. Benidir, “Signal Theory and Processing, Volume 1: Representation of Signals and Systems - Course and Corrected Exercises”, Dunod, 2004.
7. M. Benidir, “Signal Theory and Processing, Volume 2: Basic Methods for Signal Analysis and Processing - Course and Corrected Exercises”, Dunod, 2004.

Semester: 5

Teaching unit: UEF 3.1.2 Subject 2: Biophysics VHS: 45h00 (Lecture: 1h30; TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

At the end of this subject, the student should acquire knowledge enabling him to understand elements of physics essential to understanding medical diagnostic and therapy techniques which enable the exploration of living things.

Recommended prior knowledge:

Physics 1, Structure of matter and Thermodynamics of L1.

Content of the material:

The number of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1. Biophysics of Water and Solutions (1 Week)
Structure of the Water Molecule, Solutions and Solubility.

Chapter 2. Viscosity-biological hydrodynamics (2 Weeks)
Absolute coefficient of viscosity; Flow of inviscid liquids, Bernoulli's theorem, Flow of viscous liquids-pressure loss-Poiseuille's law; Measurement of viscosity-different types of equipment

Chapter 3. Surface phenomena (2 Weeks)
Surface and intrafacial tension; Cohesive energy; Pressure of curved surfaces - Laplace's law; Work of adhesion of two immiscible liquids; Capillarity phenomenon - laws; Applications: foams and emulsions, gas embolism, surfactant.

Chapter 4. Biophysics of Blood Circulation Difference (1 Week)
between blood circulation and water flow in a pipe, blood velocity in vessels, measurement of blood pressure and cardiac output.

Chapter 5. Biophysics of the gaseous state (2 Weeks)
Pressure and Pascal's law, notions of fluid statics, perfect gaseous state and gas mixture, Dissolution of gases.

Chapter 6. Biophysics of respiration Transfer (1 Week)
of gases in the body, physical bases of pulmonary ventilation (pulmonary elasticity, surface tension, Laplace pressure), physical bases of alveolar-capillary diffusion, transport of oxygen and CO2 in the blood.

Chapter 7. Geometric Optics Light (3 Weeks)
beams; Snell-Descartes laws; Concept of stigmatism; Gaussian approximation; Conjugation relationship of spherical diopters. Optical instruments (Generalities on optical instruments, the eye, the magnifying glass, the microscope); Concepts of photometry (light energy emitted by a point source, Extended source: luminance and illuminance, radiant luminance, illuminance, luminance and illuminance of images through an optical system.

Chapter 8. Introduction to radioactivity (3 Weeks)
Constitution of the atom, stable and radioactive isotopes, radioactivity: disintegrations (beta minus ß-, beta ß+, and electron capture (EC) emissions), de-excitations (Gamma), internal conversion (IC) and pair production (PP), alpha emission and spontaneous fission, laws of radioactive decay: radioactive constant and period, average life.
Activity measuring equipment.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. **J. Llory, "Medical Biophysics, Volume 1, Elements of General Physics and Physical Chemistry", 2nd edition, Sauramps Médical, 1999.**
2. **JC Mathieu-Daudet et al, "Medical Biophysics, Volume 2: Biophysics of the Living Organism", Sauramps Medical, 1999.**
3. **Pierre Galle, Raymond Paulin, "Biophysics: radiobiology, radiopathology", Edition Masson, 2000.**
4. **Doyon, "X-ray scanners", Masson Edition.**
5. **A. Aurengo, T. Petitclerc. "Biophysics, Medicine-Sciences", 3rd edition, Flammarion, 2006.**
6. **J. Dutreix et al, "Radiation Biophysics and Medical Imaging", 4th edition, Masson, 1997.**
7. **J. Giron et al, "Physical bases and evolution of radiological imaging", Masson, 1993.**
8. **A. Desgrez et al, "Physical bases of MRI", Edition Masson, 1989.**
9. **B. Kastler, "Understanding MRI", Edition Masson, 2001.**

Semester: 5

Teaching unit: UEM 3.1 Subject 1:

Practical work on servo-control and VHS regulation:

22h 30 (practical work: 1h30)

Credits: 2

Coefficient: 1

Teaching objectives:

Consolidate the knowledge acquired on control and regulation through practical work.

Recommended prior knowledge : Controls and regulation, Fundamental electronics 1, Maths 1, 2 and 3.

Subject content: TP1:

Upgrade for using Matlab toolboxes
Toolbox/Matlab, control and Simulink…

TP2: Modeling systems in Matlab and functional diagrams.

TP3: Time analysis of first and second order
and higher order LTI systems and the concept of dominant poles under Matlab and Simulink.

TP4: Frequency analysis of systems
Bode, Nyquist, Black under Matlab and Simulink.

TP5: Stability and precision of servo-controlled systems.

TP6: Synthesis of a phase advance corrector, frequency response method.

TP7: Analysis and adjustment of real analog loop systems in the laboratory
Position and speed control, temperature control, flow and level control.

Assessment method:

Continuous assessment: 100%.

Bibliographic references:

1. **K. Ogata, “Modern Control Engineering,” Third Edition; Prentice-Hall Inc., 1997.**
2. **E. Boillot, “Continuous servocontrol and regulation: Problems with solutions”, 2000.**
3. **M. Rivoire, JL. Ferrier, “Automation Exercises”, Volume 2; Chihab-Eyrolles Edition.**
4. **S. Le Ballois, “Automation: Linear and Continuous Systems”, Dunod Edition, 2006.**
5. **E. Ostertag, “Multivariable Control and Estimation”, Edition Ellipses, 2006.**
6. **P. Prouvost, “Control and Regulation”, Dunod, 2004.**

Semester: 5

Teaching unit: UEM 3.1 Subject 2:

General electronics practical work VHS:

22h 30 (practical work: 1h30)

Credits: 2

Coefficient: 1

Teaching objectives:

To enable the student to assimilate in practice the knowledge acquired in the subject of General Electronics.

Recommended prior knowledge:

Fundamental Electronics 1 and General Electronics.

Content of the material:

To direct, as far as possible, the objectives of these achievements towards the medical field by linking them to concrete applications in this field.

TP1: Study of a power amplifier assembly (with bipolar transistors, TEC, op-amp).

TP2: Applications of op-amps (inverter, differential, comparator, integrator, derivator, etc.).

TP3: Applications of op-amps in oscillators.

TP4: Applications of op-amps in filtering.

TP5: Applications of op-amps in sampling and A/D and D/A conversion.

TP6: Construction of an instrumentation amplifier.

TP7: Study of active filters: Check and test the different active filtering functions (low-pass, high-pass, band-pass).

TP8: study and creation of a timer and ramp generator with NE555.

Assessment method:

Continuous assessment: 100%.

Semester: 5

Teaching unit: UEM 3.1 Subject 3:

Medical Informatics VHS: 37h30

(Lecture: 1h30; Practical work: 1h00)

Credits: 3

Coefficient: 2

Teaching objectives:

The aim of this subject is to introduce the student to the importance of using IT tools in the medical field.

Recommended prior knowledge:

Knowledge of office software and possibly programming languages.

Content of the material:

Chapter 1. Definition and nature of medical information (3 weeks)

Types of medical information that can be stored, the different steps that can help in searching for medical information, modeling concepts, information systems, patient identification systems, medical records, confidentiality management and access to patient records.

Chapter 2. Structures and properties of a dynamic medical database management system (4 Weeks)

Microsoft Access DBMS, SQL language, database maintenance, MySQL/PHP database management system.

Chapter 3. Transport networks and archiving of medical information (3 weeks)

Classification of networks (LAN, MAN, WAN), network topology, network equipment, network types, network access protocols, archiving.

Chapter 4. Backup, archiving and transport of radiological images (3 weeks)

Formation of radiological images, saving of radiological images, uniformity of saving of radiological images, archiving, dissemination of radiological information.

Chapter 5. Interest of digitalization in conventional radiology (2 weeks)

Definition of digital radiology, digital acquisition technologies in radiology (digital fluorography, radio luminescent memory screens (ERLM), secondary digitization of X-ray films, CCD sensors, analyzer tube), digital image processing, digital image quality.

Practical work: 15 hours of practical work related to the subject

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic reference:

1. **P. Degoulet, M.Fiesch, “Medical computing”, Masson, 1998.**

Semester: 5

Teaching unit: UEM 3.1 Subject 4:

Biophysics practical work and VHS signal

practical work: 10:30 p.m. (practical work: 1:30 p.m.)

Credits: 2

Coefficient: 1

Teaching objectives:

Consolidation of acquired knowledge in signal theory and processing using a scientific programming language (Matlab, Scilab or Mathematica, etc.). Assimilation of biophysics concepts covered in class.

Recommended prior knowledge:

Numerical methods, Computer science 2 and 3, Signal theory and processing. Biophysics.

Content of the material:

This subject is divided into two separate practical work units: Signal Processing and Biophysics. The teacher(s) choose, depending on the resources available, three to four practical work sessions from each unit from the list of practical work sessions presented below.

Signal Processing Practical Work:

Practical Work1: Getting Started with Matlab: Reminders on common commands: Help (matlab help), variables, basic operations, character strings, Display, input/output, Files (script/function), upgrade for using Matlab toolboxes [Toolbox /Matlab, signal and Simulink].

TP2: Generation and display of signals: Sinusoidal, pulse, step, gate, rectangular, square, triangular, sawtooth, cardinal sine signal, study of sampling.

TP3: Fourier series: Real, complex, signal energy.

TP4: Direct and inverse fast Fourier transform (fft, ifft).

TP5: Analysis and synthesis of analog filters.

TP6: Analysis and synthesis of digital filters.

TP7: Random processes.

Biophysics practical

work: Practical work 1: Measurement of the conductivity of some electrolytic solutions (distilled water, drinking water, bleach, ethanol).

TP2: Conductometric titration: Determination of the molarity of a solution.

TP3: Measurement of the wettability of a solid surface and surface tension.

TP4: Studies of plane mirrors (by simulation)

TP5: Decomposition of light by the Prism (limit angle)

TP6: Measurement of the refractive index

TP7: Modeling the emmetropic eye and correction TP8:

Magnifying glass and/or microscope

TP9: Radioactivity: Measurement of the absorption of radiation in matter using a Geiger-Müller counter.

Assessment method: Continuous assessment: 100%.

Bibliographic references:

Semester: 5

Teaching unit: UED 3.1 Subject 1:

Waves and applications in Medical VHS: 22h 30

(Course: 1h30)

Credits: 1

Coefficient: 1

Teaching objectives:

To introduce the student to the waves used in medicine as well as the devices or apparatus whose operating and/or exploitation principle is based on these waves.

Recommended prior knowledge:

Physics, waves and vibration taught in S3.

Content of the material:

Chapter 1. General information on the different types of waves Definitions, Physical properties, Frequency range. **(1 Week)**

Chapter 2. Sound Waves (2 Weeks)
Introduction, Pressure and overpressure, Propagation equation, Connection of two media, Energy considerations, Sound waves in solids.

Chapter 3. Electromagnetic Waves (3 Weeks)
Introduction, Maxwell's equations, electromagnetic waves, case of thermal waves (Fourier-Newton law, stationary regime, time-dependent regime, solutions of the heat equation).

Chapter 4. Doppler Effect (2 Weeks)
Introduction, collinear moving source, collinear moving detector, combination, non-collinear motion, sound barrier, Cerenkov effect.

Chapter 4. Superposition of vibrations and waves (1 Week)
Introduction, Combination of vibrations of the same frequency, Composition of two vibrations of different frequencies, Interference, Standing waves.

Chapter 5. Refraction and Reflection of Light (2 Weeks)
Introduction, refractive index of the medium, total reflection, principle of optical fiber.

Chapter 6. Production, detection and application of sound waves and electromagnetic waves in medicine (4 Weeks)
Sound waves (audiometry, ultrasound, Doppler imaging), waves with wavelengths less than 400 nm (gamma rays, X-rays, Ultraviolet (UV), etc.), medical applications (radiography, scanners, etc.), the visible range: medical applications (lasers, fibroscopy, etc.), waves with wavelengths greater than 800 nm (infrared (IR), microwaves and radio waves): medical applications (thermal imaging, IR, etc.).

Assessment method:

Review: 100%.

Bibliographic references:

1. **Pierre Galle, Raymond Paulin, "Biophysics: radiobiology, radiopathology", Edition Masson.**
2. **Doyon, “X-ray scanners”, Edition Masson, 2000.**
3. **B. Kastler, “Understanding MRI”, Edition Masson, 2001.**

Semester: 5

Teaching Unit: UED 3.1 Subject 2:

Terminology and standards in biomedicine

VHS: 10:30 p.m. (Course: 1 hour 30 minutes)

Credits: 1

Coefficient: 1

Teaching objectives:

Teach the student the technical terms specific to the health field, which will allow him to understand his interlocutors in the health field on the one hand and on the other hand it will help him to establish the link between medical equipment and its field of applications.
Know the standards and rules for the use of equipment and/or processes in the biomedical field.

Recommended prior knowledge:

French, English.

Content of the material:

Chapter 1. General information on terms in human anatomy and physiology (2 Weeks)

Define the usefulness of a common language between those involved in a health act at all levels, define the medical vocabulary used for the different parts of the human body (anatomy, physiology, etc.).

Chapter 2. Clinical Terminology (2 Weeks)

Define medical vocabulary in relation to clinical procedures, pathologies, etc.

Chapter 3. Terminology Used by Medical Diagnostic Instrumentation Professionals (3 Weeks)

Define the medical vocabulary associated with diagnostic instrumentation by classifying them according to their area of intervention (bedside/patient room instrumentation, operating room instrumentation, clinical laboratory instrumentation, imaging instrumentation, renal dialysis instrumentation, etc.)

Chapter 4. Terminology used by professionals in therapy and their instrumentation (3 Weeks)

Define the medical vocabulary associated with therapeutic instrumentation by classifying them according to their area of intervention.

Chapter 5. Uses of standards in medicine and standardization bodies (2 weeks)

Definition of standards, international standardization bodies (UTE, IEC, ISO, etc.), national standardization bodies (IANOR, CETA).

Chapter 6. Study of medical standards (3 weeks)

Edition of standards, Study of the different standards relating to biomedical equipment, Evaluation of conformity.

Assessment method:

Review: 100%.

Semester: 5

Teaching unit: UET 3.1 Subject 1:

Computer-assisted maintenance VHS: 22h 30

(Course: 1h30)

Credits: 1

Coefficient: 1

Teaching objectives:

To provide students with introductory knowledge of equipment maintenance and management. To acquire the methodological tools specific to working in a professional service.

Recommended prior knowledge:

Knowledge of IT, office software and possibly a scientific programming language (Matlab, etc.).

In most cases, Computer-Assisted Maintenance is used to record information entered by technicians following an intervention. This data most often concerns: intervention request dates, intervention dates, end of intervention dates, the device concerned, the person involved, the type of breakdown, the actions carried out, the costs incurred, etc. However, MAO Management software does not have functions for processing the quality and relevance of the information entered: traceability remains their main application. Downstream of this traceability, data contained in maintenance records can be processed in order to use them to optimize biomedical maintenance activity.

Content of the material:

Chapter 1. Introduction to the maintenance function (5 Weeks)

Introduction to reliability and definition of maintenance, different diagnostic techniques, maintenance techniques (preventive maintenance, curative maintenance, etc.), maintenance methods, maintenance management and computer-assisted maintenance management (CMMS), applications of CMMS in biomedical.

Chapter 2. Maintenance of biomedical devices (5 Weeks)

Inspection and preventive maintenance of biomedical devices (Calculation of the workload related to inspection and preventive maintenance for each biomedical device, test equipment required for each category of biomedical device), corrective maintenance on biomedical devices (Component failures, Methods of finding faults on biomedical electronic devices), definitions of maintenance operations on biomedical equipment: Levels of maintenance, management and approach to maintenance, safety of biomedical devices, factors and risks affecting biomedical devices in hospitals.

Chapter 3. Application Examples (5 Weeks)

Fleet management: inventories, preventive and curative maintenance plan, stock of tools, materials, consumables and equipment required for maintenance, safety: materiovigilance, equipment monitoring, calibration, etc., operation: spare parts, consumables, maintenance, etc.

Assessment method:

Review: 100%.

Bibliographic references:

1. **Mr. Frédéric, "Implementing a CMMS - Industrial maintenance, after-sales service, maintenance real estate", Dunod, 2nd edition, 2011.**
2. **JP. Vernier, F. Monchy, "Maintenance - Methods and Organizations", Dunod, 3rd edition, 2010.**

3. Dpt of the army, "Operating guide for medical equipment maintenance, Technical bulletin, Headquarters", 1998.
4. Binseng Wang, “Medical Equipment maintenance: Management and oversight”, JD Enderle series Editor, 2012.
5. Humatem et al, "From the maintainer to the biomedical operator: for optimized operation of the medical equipment fleet", Les Houches, Humatem, 2010 (www.humatem.org).

Semester: 6

Teaching unit: UEF 3.2.1 Subject 1:

VHS digital acquisition chain: 67h30 (Lecture: 3h00; Tutorial: 1h30)

Credits: 6

Coefficient: 3

Teaching objectives:

Understand how a measurement chain works and identify its components. Design and build a data acquisition card using specialized circuits. Implement communication between an acquisition card and a computer (PC) through a communication interface and develop software to control the data acquisition card.

Recommended prior knowledge:

Sensors, general electronics and electrical measurements, digital electronics, computer programming.

Content of the material:

Part A: Conditioning circuits Chapter 1. **(5 weeks)**

Introduction to data acquisition chains Definition, description of an acquisition chain: sensor, conditioning circuit, analog-digital converter, communication interface, computer (PC), acquisition control software.

Chapter 2. Reminders on Operational Amplifiers
Operational amplifiers, Main characteristics, Applications on operational amplifiers.

Chapter 3. Packaging Definition
of a conditioner, types of packaging, packaging circuits.

Part B: Conversion circuits **(6 weeks)**

Chapter 4. Digital-to-Analog Conversion Definition
of a DAC, characteristics of a DAC, principle and circuit, main digital/analog conversion techniques.

Chapter 5. Analog to Digital Conversion Definition
of an ADC, characteristics of an ADC (digital resolution, input range, conversion error, conversion time), sampling: principle and circuit, blocking: principle and circuit; main analog/digital conversion techniques.

Chapter 6. Study of CAN by specialized circuits
Presentation of certain specialized circuits in CAN, general characteristics, pinout and description of the functions of each pin, internal description, operating principle, application circuits for CAN (single conversion, continuous conversion).

Part C: Managing an Acquisition Chain **(4 weeks)**

Chapter 7. Managing an Acquisition Chain - Application
Presentation of the development tool. Structure of a program, The basics of the programming language, Examples of programs, Hardware communication.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

1. G. Asch et al, Data Acquisition: From Sensor to Computer, 3rd ed., Dunod, 2011.
2. F. Cottet, Signal processing and data acquisition: Courses and exercises, Dunod, 2009.
3. F. Cottet et al, LabVIEW: Programming and Applications, Dunod, 2009.
4. A. Migeon, Industrial Applications of Sensors: Volume 2, Medical, Chemical and Plastics Sectors, Hermes Science Publications, 1997.
5. G. Asch and Collaborators, Sensors in industrial instrumentation, Dunod 2006.
6. Ian R. Sinclair, Sensors and transducers, Newness, 2001.
7. JG Webster, Measurement, Instrumentation and Sensors Handbook, Taylor & Francis Ltd.
8. M. Grout, Industrial Instrumentation: Specification and installation of sensors and control valves, Dunod, 2002.
9. R. Palas-Areny, JG Webster, Sensors and Signal Conditioning, Wiley & Sons, 1991.
10. AP Malvino, Principles of Electronics, 6th ed., Sciences-Sup, Dunod.
11. J. Millman, Microelectronics, Ediscience.
12. JD. Chatelain and R. Dessoulavy, Electronics, Volumes 1 and 2, Dunod.
13. D. Barchesi, Physical Measurement and Instrumentation, Ellipses, 2003.
14. Documents on Labview: http://www.ni.com/pdf/manuals/374029b_0114.pdf

Semester: 6

Teaching unit: UEF 3.2.1 Subject 2:
Biomaterials VHS: 45h00

(Lecture: 1h30; TD: 1h30)
Credits: 4

Coefficient: 2

Teaching objectives:

To enable the student to understand the different classes of biomaterials and to link their properties to the areas of their possible uses. He will thus be able to understand the phenomena that could occur during the interaction of the biomaterial with biological tissue.

Recommended prior knowledge:

Subjects Physics 1 and Structure of matter of L1.

Content of the material:

The number of weeks displayed is for informational purposes only. It is clear that the course leader is not required to strictly adhere to this dimension or the arrangement of the chapters.

Chapter 1. Concepts of biocompatibility (1 week)
Surfaces of solids and adhesion, biological tissues and cells, effects of the host on the implant and of the implant on the host, degradation of materials in a biological environment.

Chapter 2. Elements of physics of solid biomaterials (4 weeks)
Elements of crystallography; Chemical bonds in solids; vibrations of atomic chains, thermal properties of a solid biomaterial (heat capacities, expansion, etc.),

Chapter 3. Mechanical properties of biomaterials (3 weeks)
Definitions of the main mechanical properties of solid biomaterials (hardness, resilience, malleability, elasticity, ductility, etc.); Resistance of biomaterials to mechanical stresses (compression, torsion, bending, shear).

Chapter 4. Mechanisms of biomaterial degradation (3 weeks)
Corrosion, wear, aging, dissolution, oxidation, biodegradation, etc.; Consequences of biomaterial degradation on the implant and the host.

Chapter 4. Metallic Biomaterials (1 week)
Classification of metals, properties of biocompatible metals; main metallic biomaterials, properties and main applications of biocompatible metals in biomedicine.

Chapter 5. Ceramic and composite biomaterials (1 week)
Classification of ceramics, properties of ceramics; main ceramic and composite biomaterials; main applications of ceramics and composites in biomedicine.

Chapter 6. Polymeric biomaterials (1 week)
Definition of a polymer, polymerization reactions, definition of certain properties of polymers (thermoplastic materials, thermosetting materials, elastomers, etc.); main polymeric biomaterials; biodegradability and concept of inert/bioactive polymers; main applications of polymers in biomedicine.

Chapter 7. Natural Biomaterials **(1 week)**
Main natural biomaterials and their applications in biomedicine.

Assessment method:

Continuous assessment: 40%, Exam: 60%.

Bibliographic references:

1. J. Park, RS Lakes, "Biomaterials: An Introduction", Springer Science & Business Media, 2007.
2. M. Degrange, L. Pourreyron, "Francophone Society of Dental Biomaterials (SFBD)" (Online book (http://umvf.univ-nantes.fr/odontologie/)
3. B. Ratner et al, “Biomaterials science: An Introduction to Materials in Medicine”, Academic Press, 1996.

Semester: 6

Teaching unit: UEF 3.2.2 Subject 1:
Medical instrumentation VHS: 45h00 (Lecture:

1h30; TD: 1h30)
Credits: 4

Coefficient: 2

Teaching objectives:

To introduce the student to the equipment used in hospitals in the field of therapeutics. To teach them about the different physiological parameters in diagnosis as well as the appropriate electronic approaches to detect and measure them for monitoring purposes.

Recommended prior knowledge:

Anatomy, Human Physiology, Servo Control, Signal Processing.

Content of the material:

Chapter 1. General Introduction to Medical Instrumentation (3 Weeks)

Context and necessity, certification of devices and notion of conformity, clinical aspects: qualities and imperfections seen by the practitioner, biomedical sensors, technical specifications, classes of devices and patient safety.

Chapter 2. Diagnostic Instrumentation (3 Weeks)

Operating principle, Synoptic description, Methods of use and examples of commercial devices: electrocardiogram (ECG), blood flow measurement, electroencephalogram (EEG), plethysmography, pneumotachography, Spirometer, etc.

Chapter 3. Clinical Instrumentation (3 Weeks)

Operating principle, synoptic description, Terms of use and examples of commercial devices of the devices: blood composition analyzers: oximeter, glucometer, lactic acid, cholesterol, blood pressure monitor, bioimpedance meter, ultrasound, etc.

Chapter 4. Medical Assistance Instrumentation (3 Weeks)

Operating principle, synoptic description, methods of use and examples of commercial devices: hemodialyzer, cardiac pacemakers (Pacemaker), defibrillators, artificial respirators (ventilators), etc.

Chapter 5. Therapeutic Instrumentation (3 Weeks)

Operating principle, synoptic description, methods of use and examples of commercial devices: Radiotherapy, lasers, UV radiation.

Assessment method:

Continuous assessment: 40%, Exam: 60%.

Bibliographic references:

15. **S. Ananthi. “A Text Book of Medical Instruments”, New Age International, 2005.**
16. **S. Chatterjee, A. Miller. “Biomedical Instrumentation Systems”, Cengage Learning, 2011.**
17. **J. Webster, "Medical Instrumentation: Application & Design, John Wiley Edition, 2009.**
18. **E. Moerschel, JP. Dillenseger. "Guide to Medical Imaging and Radiotherapy Technologies, 2009.**
19. **S. Heywang-Köbrunner et al, "Diagnostic imaging of the breast: mammography, ultrasound, MRI, interventional techniques, 2007.**
20. **J. Webster, "Encyclopedia of Medical Devices and Instrumentation, Vol.1, 2nd Ed, Wiley, 2006.**

Semester: 6

Teaching unit: UEF 3.2.2 Subject 2:

Processing of physiological signals VHS: 45h00

(Lecture: 1h30; TD: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives:

This subject is primarily intended for the processing of various physiological signals. At the end of this course, the student will be able to recognize a physiological signal and process it to enable better interpretation of the medical procedure.

Recommended prior knowledge:

Signal Theory and Processing, General Anatomy and Physiology.

Content of the material:

Chapter 1. Electrical Nature of Physiological Signals (2 Weeks)

Definition of physiological signals, origin of bioelectric signals and their electrical characteristics: Generation of the cardiac electrical signal (potential electrocardiogram/ECG/), of the muscular signal (electromyogram/EMG/) and of the cerebral signal (electroencephalogram/EEG/).

Chapter 2. Measurements of physiological signals (3 weeks)

Description of physiological signal acquisition chains: principles of biomedical sensors and their characteristics, criteria for choosing sensors, description of measurement methods, influence of noise on the physiological signal, case of ECG, EEG, PCG and EMG devices.

Chapter 3. Origins of noise in physiological signals (3 Weeks)

Physiological origins: dysfunction in the physiological system (heart, brain, muscle, etc.), effect of external and environmental constraints on the physiological signal, instrumental origins (noises linked to pre-amplification and amplification of the recorded signal, noises linked to the recording of the signal, noises linked to cables, electrodes and their placement, etc.).

Chapter 4. Spectral Analysis and Modeling (4 Weeks)

Reminders on the digital Fourier transform, analysis method, methods of estimating the spectral density of a physiological signal (periodogram and correlogram), modeling, linear prediction and structure of the predictor.

Chapter 5. Processing of noisy physiological signals (3 Weeks)

Extraction of information from a noisy signal and Pattern recognition.

Assessment method:

Continuous assessment: 40%; Exam: 60%.

Bibliographic references:

18. **M. Akay, "Non linear biomedical signal processing", John Wiley Edition, 2000.**
19. **Suresh R. Devasahayam, “Signals & systems in biomedical engineering” John Wiley Edition, 2012.**
20. **R. C. Gonzalez, REWoods, "Digital Image Processing", Prentice Hall Inc., 2002.**
21. **R. Garello, "Analysis of two-dimensional signals", Edition Hermès, 2001.**
22. **M. Bellanger, "Digital Signal Processing", 4th edition, Masson, 1990.**
23. **E. Tisserand et al. "Signal Analysis and Processing - Methods and Applications to Sound and Image", 2 edition, 2009.**

Semester: 6

Teaching unit: UEM 3.2 Subject 1:

End of Cycle Project (Hospital environment)

VHS: 45h00 (TP: 3h00)

Credits: 4

Coefficient: 2

Teaching objectives:

Allows the student to acquire practical knowledge of an environment related to the specialty (university hospital, hospital, center, laboratory, company, etc.). The internship can be devoted to the discovery of one or more medical devices as well as to a service or the technical management of the equipment in this environment.

Recommended prior knowledge:

All fundamental and methodological subjects.

Content of the material:

Supervised internship to be carried out in a healthcare setting. This internship can be carried out in pairs of students. Students will learn about the various pieces of equipment (how they are used and/or operate, the signals or parameters they provide, etc.) and the computer software used in this environment. It will also teach them about the various approaches used for hardware and computer maintenance.

At the end of their internship, students submit a report detailing the main activities and scientific and/or technical knowledge acquired during this activity. Students present the results of their internship to the instructor in charge of the internship.

Note: it is recommended to assign this subject (End of Cycle Project) and the Model subject to the same teacher so that the student can take full advantage of the time allocated to this subject to advance in their model creation project.

Assessment method:

Continuous assessment: 100%.

Semester: 6

Teaching unit: UEM 3.2 Subject 2:

Practical work VHS digital acquisition chain: 22h30 (practical work: 1h30)

Credits: 2

Coefficient: 1

Teaching objectives:

Consolidate the knowledge acquired in the subject Digital Acquisition Chains.

Recommended prior knowledge:

Fundamental and General Electronics. Servo Control.

Content of the material:

An average of 06 practical exercises, from the list of practical exercises presented below, must be provided in this subject, depending on the resources available in the establishment. These practical exercises can be of the simulation type and/or of the experimental type.

TP1: Practical Reminder on Operational Amplifier-based circuits

TP2: Scaling an analog signal: creation of a scaling circuit (conditioner) based on operational amplifiers.

TP3: Practical study of the Sample/Block function.

TP4: Practical Study of Digital to Analog Conversion Techniques.

TP5: Practical Study of Analog to Digital Conversion Techniques.

TP6: Practical study of circuits specialized in analog-digital conversion.

TP7: Acquisition card for a physical quantity: creation of an acquisition card.

TP8: Development of an application for managing an acquisition card by computer.

TP9: Establishing communication between a CAN card and a PC.

Assessment method:

Continuous assessment: 100%.

Bibliographic references

1. G. Asch et al, Data Acquisition: From Sensor to Computer, 3rd ed., Dunod, 2011.
2. F. Cottet, Signal processing and data acquisition: Courses and exercises, Dunod, 2009.
3. F. Cottet et al, LabVIEW: Programming and Applications, Dunod, 2009.
4. A. Migeon, Industrial Applications of Sensors: Volume 2, Medical, Chemical and Plastics Sectors, Hermes Science Publications, 1997.
5. Documents on Labview: http://www.ni.com/pdf/manuals/374029b_0114.pdf

Semester: 6

Teaching unit: UEM 3.2 Subject 3:

Practical work on instrumentation and VHS

signal: 10:30 p.m. (practical work: 1:30 p.m.)

Credits: 2

Coefficient: 1

Teaching objectives:

Assimilation of knowledge acquired in the subjects Medical instrumentation and processing of physiological signals.

Recommended prior knowledge:

Notions on signal processing, knowledge of Matlab.

Content of the material:

This subject is split into 2 separate practical work units: Medical Instrumentation and Treatment of physiological signals. The teacher(s) choose, depending on the resources available, 3 to 4 practical exercises from each unit from the list of practical exercises presented below. These practical exercises can be simulation-type and/or experimental-type.

Medical Instrumentation Practical Work:

TP1: ECG: measurement of the ECG signal.

TP2: PCG: study of a PCG phonocardiography system.

TP3: EMG: study of an EMG signal measurement system.

TP4: EEG: study of an EEG signal measurement system.

TP5: Measurement of blood pressure and acquisition of its signal.

TP6: Respiratory system measurement: study of a respiratory flow measurement system.

TP7: Bio-impedancemetry measurements.

TP8: Characterization of different biomedical detectors and sensors (scintillators, measuring electrodes, etc.).

Practical work on Physiological Signal Processing:

Practical work 1: Time analysis, identification of the different waves, intervals and segments of the ECG signal, the signal correlation function.

TP2: Frequency analysis, determine the power spectrum of the signal using two different methods: periodogram and correlogram.

TP3: Time-frequency analysis, determine the spectrogram of the ECG signal and identify the strongest frequencies.

TP4: Statistical analysis, determine the probability density of ECG signal and its different statistical characteristics.

TP5: Filtering, elimination of the effect of noise.

TP6: Detection of RR peak, detection of heart rate.

Assessment method:

Continuous assessment: 100%.

Semester: 6

Teaching unit: UEM 3.2 Subject 4:

VHS models: 3:00 p.m.

(practical work: 1:00 p.m.)

Credits: 1

Coefficient: 1

Teaching objectives:

To familiarize the student with the practical side of their training through the study and creation of assemblies in the biomedical field.

Recommended prior knowledge:

General electronics, servo control. Instrumentation.

Content of the material:

- **ÿ Establishment of the specifications for the assembly to be designed.**
- **ÿ Design and theoretical calculations of the circuit.**
- **ÿ Simulation by Workbench, Pspice or Proteus.**
- **ÿ CAD routing.**
- **ÿ Manufacturing of the printed circuit.**
- **ÿ Completion of the assembly.**
- **ÿ Testing the model.**

This teaching aims to implement the knowledge acquired by the student during the previous semesters, through the implementation of a practical project related to his training. This model may not be exclusively electronic, but the main thing is that it is related to his training in biomedical engineering.

The work is validated by the writing of a report, by a presentation (oral or on poster) and by the presentation of the practical work with an explanation of all the functions.

Assessment method:

Continuous assessment: 100%.

Bibliographic references:

1. **JP Oemichen, "Printed Circuit Technology", Radio Publishing, 1977.**
2. **JF Pawling, “Surface Mounted Assemblies”, Electrochemical Publications, 1987.**

Semester: 6

Teaching unit: UED 3.2 Subject 1:

Safety of Biomedical Devices VHS: 22h30 (Course: 1h30)

Credits: 1

Coefficient: 1

Teaching objectives:

This subject aims to raise student awareness of taking into consideration the safety of medical devices to protect them and avoid their misuse and also to ensure the safety of those involved in any health procedure.

Recommended prior knowledge:

Content of the material:

Chapter 1. Description of the different dangers in a hospital environment (1 Week)

Dangers incurred by the practitioner, Dangers incurred by the technician, Dangers incurred by the patient, Dangers incurred by the equipment.

Chapter 2. Electrical safety in hospitals Standards on electrical installations, safety tests. **(1 Week)**

Chapter 3. Equipment protection equipment Power distribution: earthing system, insulation, equipment design **(2 Weeks)**

Chapter 4. Equipment Safety (3 Weeks)

General standards for certification of electromedical devices, safety of systems (interconnected systems and devices, monitoring systems and devices, patient assistance (intensive care), monitoring), electrical safety analyzers: safety testing in medical systems.

Chapter 5. Personnel Safety (6 Weeks)

Concepts of leakage current, its origins and effects on those involved in a health sector (practitioners, patients, staff), physiological effects of electricity (perception threshold, respiratory paralysis, ventricular fibrillation, myocardial contraction, burns, etc.), sensitivity parameters (threshold, frequency, duration, weight), main risks incurred by patients when using medical electrical equipment, distribution of electrical energy (patient's electrical environment, isolated power supply system, emergency power supply system), basic approach to protection against electroshocks, electrical faults in equipment, standards and protection of radiation doses emitted or received by staff or patients, fundamental optimization practices in infection prevention.

Chapter 6. Hospital Waste Management (2 Weeks)

Preventive measures for handling radioactive waste, biomedical waste, treatment and disposal of hospital waste.

Assessment method:

Review: 100%.

Semester: 6

Teaching unit: UED 3.2 Subject 2:

Elements of robotic systems

VHS: 10:30 p.m. (Class: 1.5 hours)

Credits: 1

Coefficient: 1

Teaching objectives:

This course aims to introduce students to the basics of telemedicine through concepts of automatic controls and robotics.

Recommended prior knowledge:

General electronics, Servo control.

Content of the material:

Chapter 1. General information about robots

Chapter 2. Use of robots in medicine

Chapter 3. Sensors and actuators in robotics

Chapter 4. Representation and modeling of robots

Chapter 5. Control and remote manipulation of robots

Chapter 6. Medical Robots: Case Studies.

Assessment method:

Review: 100%.

Bibliographic references :

1. **J. Troccaz. "Medical robotics, IC2 treatise, Automated Systems series", Hermès-Lavoisier, 2012.**
2. **A. Hubert. "Control of dynamic systems: introduction to the modeling and control of automatic systems", Franche-Comté University Press, 2008.**
3. **P. Coiffet, "Robotics, principles and applications", 3rd edition, 1992, Hermes, 1992.**
4. **B. Siciliano, O. Khatib, "Handbook of Robotics", Springer. 2016.**

Semester: 6

Teaching unit: UET 3.2 Subject 1:

Professional project and business management VHS: 10:30 p.m.

(Course: 1:30 p.m.)

Credits: 1

Coefficient: 1

Teaching objectives:

Prepare and master the methodological tools necessary for professional integration at the end of studies, prepare for the job search. Be made aware of entrepreneurship by presenting an overview of management knowledge useful for the creation of activities and be able to implement a project.

Content of the subject:

Chapter 1: Business and Society (3 weeks)

The Company: Definition and objectives of the company. Different forms of business, company structure, personnel and partners of the company.
Different types of business (VSE, SME, SMI, ETI, GE)
The company: Definition and objectives of the company Different types of company (SARL, EURL, SPA, SNC,)
Difference between business and corporation.

Chapter 2: Operation and organization of the company (2 weeks)

Organization and operation of the company The main functions of the company (production company, service company, etc.)
Company structure (definition and characteristics)
Different types of structures (functional, divisional, multidivisional, hierarchical-functional "staff and line").
Additional activities of the company (partnership, subcontracting, etc.).

Chapter 3: How to get into a business (3 weeks)

Personnel needs and quality (senior executives, managers, technicians, workers, etc.)

Where to find the job offer (ANEM, section, internet, etc.)
How to go about it (the application, the CV)
The different types of job interviews and how to approach one.
Types of employment contracts (permanent and fixed-term contracts)
Salary (how a pay slip is calculated).

Chapter 4: How to Start Your Own Business (3 weeks)

The business creator's journey (the idea, the capital, financial aid, etc.)
How to find a good idea.
Financial aid schemes for investment (ANSEJ, CNAC, ANDI, ANGEM, PNR)

Chapter 5: Study of a business creation project (4 weeks)

Studying a business creation project requires the promoter to make the effort to plan and write down in detail the phases and steps that he will have to take to get his business off the ground.

Market research (sales department, marketing, etc.).
Technical study (location, equipment and machinery requirements, production capacity, etc.).
Financial study (turnover, salary costs, expenses and consumption, taxes, etc.).

Mini project for the study of a business creation project

Assessment method: 100% exam

Bibliographic references:

1. -Antoine Melo " Business Management" Melo France 2016 edition 2.
-Thomas Durand Business Management" Paperback Edition 2016
3. -Philippe Guillermic Business Management Step by Step Pocket Edition 2015
4. -Guy Raimbault "Management tools," Chihab edition Algiers
1994 5. -Institute of financial Accounting initiation "OPU Algiers 1993
technology 6. -Christian Bultez "Guide and instructions for the procedures Nathan Paris edition 1993

IV- Agreements / Conventions

STANDARD LETTER OF INTENT

(In case of a license co-sponsored by another university establishment)

(Official paper on the letterhead of the university establishment concerned)

Subject: Approval of co-sponsorship of the license entitled:

The above-mentioned university (or university center) declares co-sponsorship of the hereby grants the license for the entire period of authorization of the license.

To this end, the university (or university center) will assist this project by:

- Giving their point of view in the development and updating of teaching programs, - Participating in seminars organized for this purpose, - Participating in defense juries, - Working towards the pooling of human and material resources.

SIGNATURE of the legally authorized person:

FUNCTION :

Date :

STANDARD LETTER OF INTENT

(In case of license in collaboration with a company in the user sector)

(Official company letterhead)

SUBJECT: Approval of the project to launch a Bachelor's degree course entitled:

Provided to:

The company hereby declares his will to demonstrate his provides support for this training as a potential user of the product.

To this end, we confirm our support for this project and our role will consist of:

- **Give our point of view in the development and updating of programs teaching,**
- **Participate in seminars organized for this purpose,**
- **Participate in defense juries,**
- **Facilitate as much as possible the reception of interns either within the framework of theses or end of studies, or within the framework of supervised projects.**

The means necessary to carry out the tasks incumbent upon us to achieve these objectives will be implemented on a material and human level.

Mr (or Mrs)*……is designated as external coordinator of this project.

SIGNATURE of the legally authorized person:

FUNCTION :

Date :

OFFICIAL STAMP or COMPANY SEAL

V - Opinions and Visas of the Administrative and Consultative Bodies

Degree Title: Biomedical Engineering

Department Head + Domain Team Leader	
Date and visa:	**Date and visa:**
Dean of the Faculty (or Director of the Institute)	
Date and visa:	
Head of university establishment	
Date and visa:	

VI – Notice and Visa of the Regional Conference

VII – Opinion and Visa of the National Educational Committee of the Domain