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

جامعة محمد خيضر
بسكرة
Mohamed Khider University of Biskra

TRAINING OFFER
L.M.D.

ACADEMIC LICENSE

NATIONAL PROGRAM
2021– 2022
(2nd update)

Establishment	Faculty / Institute	Department
Mohamed Khider University of Biskra	***Faculty of Science and Technology***	***Mechanical Engineering***

Field	Section	Speciality
Science And Technologies	***Mechanical Engineering***	***Energetic mechanics***

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اللجنة البيداغوجية الوطنية
لميدان العلوم و التكنولوجيا
National Educational Committee for the Field of Science and Technology

عرض تكوين
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ليسانس أكاديمية

برنامج وطني
2022- 2021

المؤسسة	الكلية/ المعهد	القسم
جامعة محمد خيضر بسكرة	كلية العلوم والتكنولوجيا	الهندسة الميكانيكية

الميدان	الفرع	التخصص
علوم وتكنولوجيا	هندسة ميكانيكية	طاقوية

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I – License identity card

1 - Training location:

Faculty (or Institute) :

Department :

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

2- External partners:

Other partner establishments:

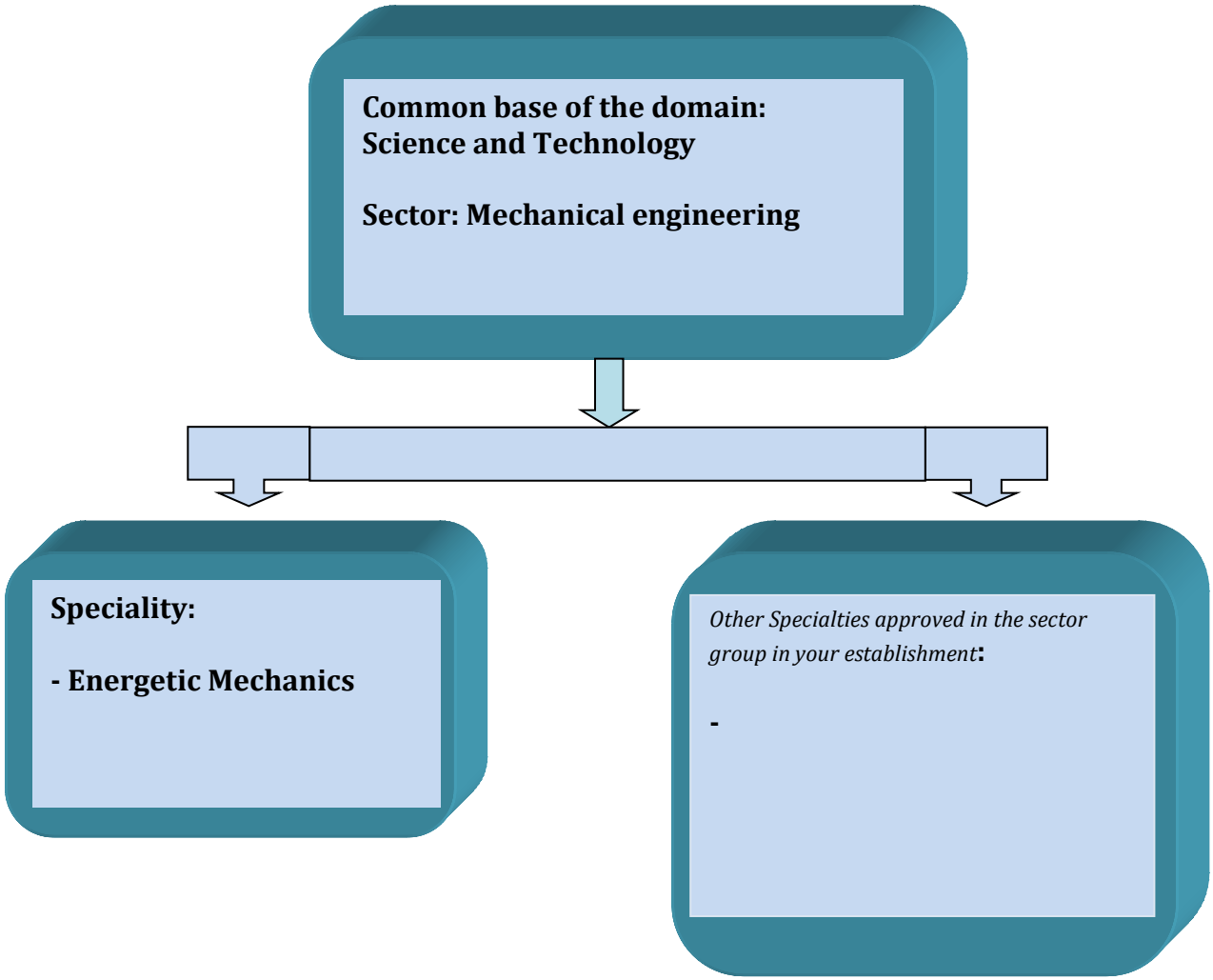
Businesses and other socio-economic partners:

International partners:

3 – Training context and objectives

A – General organization of training: project position

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 Sector Group. Specify with an asterisk any other license whose supervision is also ensured by a large part of the teachers involved in this present license. Indicate frozen licenses with a double asterisk. Also mark with (P) any professional type license.



B - Training objectives:

Acquire the reflexes of an energy specialist, be able to take the energy balance of any mechanical system, consumer or generator of energy in any form whatsoever, to then be able to decide on its vitality or locate its failures. This is the ambitious objective of this training.
The License in Energy Mechanics offered allows the holder of his diploma to adapt as quickly as possible in the various professions linked to the production, generation, transport, transformation and use of energy. The professions of industrial air conditioning, cold production, heating, domestic air conditioning, thermal, solar, hydraulic, geothermal, wind turbines, engines, etc. are thus targeted by our training.
Thanks to solid training in thermodynamics and applied thermodynamics, heat transfers, fluid mechanics, turbomachines, engines, renewable energies, cold and climate engineering, the energy graduate will be able to easily adapt and build skills in all professions related to energy.

C – Targeted profiles and skills:

The academic degree in energy prepares for Master's training in a multitude of specialties through its program rich in basic teaching. On the other hand, this training prepares the graduate to enter various potential sectors of activity:

- Design offices, Characterization analysis, Consulting expertise;
- SMEs in mechanical industries
- Maintenance of the machine park, etc.

D – Regional and national employability potential:

This License offers real professional opportunities in many sectors, namely:

- Transport of all types of fluids (water, gas, oil, pressurized water).
- Thermal power plants.
- Solar and hydraulic power plants, gas power plants and thermal engine groups.
- Cold, production and distribution, liquefaction of natural gas and its derivatives.
- Liquefaction of air and its components for industry and medicine.

E – Gateways to other specialties:

Common semesters 1 and 2	
Sector	**Speciality**
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
Optical and precision mechanics	Optics and photonics
	Precision engineering
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 domain

Group of sectors A	Common semester 3
Sector	**Speciality**
Automatic	Automatic
Electromechanics	Electromechanics
	Industrial maintenance
Electronic	Electronic
Electrical engineering	Electrical engineering
Biomedical engineering	Biomedical engineering
Industrial Engineering	Industrial Engineering
Telecommunication	Telecommunication

Group of sectors B	Common semester 3
Sector	**Speciality**
Aeronautics	Aeronautics
Civil engineering	Civil engineering
Climate engineering	Climate engineering
Marine 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 photonics
	Precision engineering
Sector	Public works

Group of sectors B	Common semester 3
Filière	**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 sectors which present basic lessons common to each other (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 transversal teaching programs:

Multidisciplinary, in the sense that the lessons 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 lessons of semester 3 for all the specialties of the same group of sectors are also 100% identical.

Semester	Sector group	Common teachings
Semestre 1	A - B - C	(30 / 30) Crédits
Semestre 2	A - B - C	(30 / 30) Crédits
Semestre 3	A - B	(18 / 30) Crédits
	A - C	(18 / 30) Crédits
	B - C	(24 / 30) Crédits

In a transversal way, this License offers the student the choice of joining, if they express the desire and depending on the educational places available:

- All other specialties in the ST field at the end of semester 2.

- All specialties in the same group of sectors at the end of semester 3.

- All specialties from another group of sectors at the end of semester 3 (Subject to equivalence and advice from the training team).

- All specialties in the same group of sectors at the end of semester 4 (Subject to equivalence and advice from the training team).

F – Performance indicators expected from training:

All training must meet the quality requirements of today and tomorrow. As such, to better appreciate the expected performance of the training proposed on the one hand and by exploiting the flexibility and flexibility of the LMD system on the other hand, it is proposed for this license a certain number of mechanisms to evaluate and monitor the course of teaching, 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 as to the quality of the graduates recruited and/or the teaching provided .

The evaluation methods can be implemented through surveys, on-site monitoring of students in training and survy with recruited students who hold this License as well as with their employers.

Any study or investigation or event will then be the subject of a report which will be distributed and archived.

1. Evaluation of the course of the training:

In addition to the regular meetings of the educational committee, a meeting at the end of each semester will be organized. It will bring together teachers and students from the promotion to discuss any problems encountered, possible improvements to be made to teaching methods in particular and to degree training in general.

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

Before the training:

- ✓ Rate of students having chosen this License (Supply/demand ratio).
- ✓ Relationship between supervision capacity and the number of students requesting this training.
- ✓ Evolution of the number of requests for registration for this license over previous years.
- ✓ Rate and quality of students who choose this license.
- ✓ Participation in support actions put in place to promote the specialties of the sector (their objectives, opportunities, etc.) for common core students.

During training:

- ✓ Regularity of meetings of educational committees and archiving of minutes.
- ✓ Inventory of recurring problems raised during these meetings and not resolved.
- ✓ Validation of End of Cycle Project proposals during a training team meeting.
- ✓ Appointment of a teacher/mediator/contact with students who will activate in parallel and outside of educational committee meetings:
  (The mediator is a teacher, having easy contact with students and open to discussions, who will interface between students and the administration to resolve critical or urgent problems that may possibly arise between students and a teacher).

After the training:

- ✓ Number and success rate of students in this Degree.
- ✓ Number and success rate in the transition from one semester to another.
- ✓ Rewarding and encouraging the best students.
- ✓ Number and rate of attrition (failures and abandonments) of students.
- ✓ The causes of student failure are listed.
- ✓ Organization of catch-up sessions for students in difficulty.
- ✓ Reorientation alternatives are offered to students in a situation of failure.
- ✓ Number and rate of students from this training who obtain their diploma within a reasonable time.
- ✓ Number, rate and quality of students from this training who continue their studies in Masters.
- ✓ Number, rate and quality of students from this training who continue their studies in Doctorate.
- ✓ Survey on student satisfaction rate on lessons and teaching methods.
- ✓ Quality of students from this training who obtain their diploma (quality criteria to be defined).

2. Evaluation of the progress of programs and courses:

The teachings in this course will be subject to regular evaluation (biennially or triennially) by the training team and will then be sent, upon request, to the various institutions: National Educational Committee for the Field of Sciences and Technologies, Regional Conferences , Vice-rectorate in charge of teaching, Faculty, ...

As a result, a system for evaluating programs and teaching methods can be put in place based on the following indicators:

- The teaching rooms are equipped with support materials for educational improvement (projection systems (data shows), wifi connection, etc.).
- Educational laboratories with the necessary equipment in line with the training content.
- Existence and use of the intranet in educational laboratories and computing centers.
- Existence of anti-virus software and educational software in educational laboratories and computing centers.
- IT resources maintenance contracts with suppliers.
- Training of technical staff on IT resources and educational materials.
- Existence of a communication and teaching platform in which courses, tutorials and practical work are accessible to students and their questions resolved.
- End of Study and/or End of Cycle dissertations are digitized and available.
- Additional training in foreign languages for the benefit of available students.
- Rate of renovation and use of educational materials.
- Number of TPs carried out as well as the multiplication of the type of TPs per subject (diversity of TPs).
- Easy access to the library (sufficient number of library access spaces, remote access to works via internal and external networks, opening hours extended beyond teaching hours, etc.)
- Number and rate of acquisition of works by the establishment's library related to the specialty.
- Rate of use of works, available in the establishment's library, related to the specialty.
- Adequacy of programs in relation to industrial needs and updating proposals.
- Involvement of professional executives in teaching (visit to the company, course-seminar given by professionals on a subject or aspect of interest to the company but not covered by the teaching, etc.)
- Involvement of professionals in the creation or modification of a subject or part of a teaching subject (courses, practical work) according to industrial needs.
- Registration of new Masters courses, downstream of this training, in the establishment's project.
- Opening of new Masters in relation to the specialty.

3. Integration of graduates:

A coordination committee will be created, made up of those responsible for training and members of the Administration, which will be mainly responsible for monitoring the integration of graduates from the sector into professional life, and creating a student monitoring file. graduates from the sector, to identify and/or update the existing economic and industrial potential at the regional and national level, to anticipate and encourage new professions in relation to the sector in association with the chamber of commerce, the various agencies support for employment, public and private operators, etc., to participate in any action concerning the professional integration of graduates (organization of events with socio-economic operators).
To carry out these missions, this committee will have complete freedom to carry out or commission any study or survey on the employment and post-employment of graduates.
Below is a list of indicators and modalities that could be considered to evaluate and monitor this project:

Professional integration of graduates:

- ✓ Recruitment rate of graduates into professional life in a position directly related to training.
- ✓ Possibility of recruitment in different sectors in relation to the title of the training.
- ✓ Recruitment of graduates of this Degree in other sectors.
- ✓ Nature of jobs held by students at the end of their studies.
- ✓ Number and rate of students leaving this training occupying positions of responsibility in companies.
- ✓ Diversity of outlets.
- ✓ Degree of adaptation of the graduate recruited into the workplace.
- ✓ Success of candidates in professional integration.
- ✓ The speed of absorption of graduates into the world of work.
- ✓ Creation of a file of graduates from the sector.
- ✓ Installation of an association of former graduates of the sector.
- ✓ Organization of specific training for graduate students to succeed in recruitment competitions.
- ✓ Availability of information on possible employment positions in the region.
- ✓ Potentialities implicit in this business creation training.
- ✓ Additional training on entrepreneurship provided.
- ✓ Creation of small businesses by graduates of the specialty.

The interest shown by the professional in the specialty

- ✓ satisfaction Level of potential employers
- ✓ Interest shown by employers in the specialty.
- ✓ Relevance of the specialty for the world of work.
- ✓ Survey on the evolution of professions/jobs in the sector.
- ✓ Sustainability and consolidation of relationships with manufacturers, particularly following end-of-cycle internships.
- ✓ Monitoring of agreements (University/Company) and evaluation of relations between the company and the university.
- ✓ Organization of events (open days, forums, workshops) with socio-economic operators concerning the professional integration of graduates.

G- Student evaluation through continuous assessment and personal work:

G1- Evaluation through continuous assessment:

The importance of continuous assessment methods on student training in terms of educational outcomes no longer needs to be demonstrated. In this regard, articles 20, 21 and 22 of decree 712 of November 3, 2011, define and specify the modalities as well as the organization of the continuous evaluation of students according to the training course. The calculation of the continuous assessment averages (supervised work and practical work) is made from a weighting of all the elements which constitute this evaluation. These articles specify that this weighting is left to the discretion of the teaching team.

A survey carried out by the CPND-ST among all teachers in the different university establishments showed heterogeneity in the implementation of continuous assessment of students. Also, we are led to admit a real deficit in the effective management of this educational activity which required on our part serious reflection on this subject which, combined with the proposals emanating from several establishments, resulted in the recommendations below. below.

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

1. Proposals relating to subjects with tutoriel:

1.1. Preparing for a series of exercises:

The teacher responsible for the subject will have to propose 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 in a tutorial session.
These exercises must be prepared by the student before coming to the tutorial. This preparation can be evaluated. The evaluation method is left to the discretion of the teacher responsible for the tutorial.
The exercises not solved in tutorial can be the subject of personal work to be carried out by groups of 3 to 4 students and to be submitted for evaluation (deadline: 1 week).

1.2. Written test

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

1.3. Student participation in tutorials:

This participation must be evaluated. The evaluation method is left to the discretion of the teacher responsible for the tutorial.

1.4. Student Attendance:

Student attendance is compulsory in tutorials and PW. In class, it is difficult to control it for undergraduate students where the numbers are very large (lectures in an amphitheater). For masters where numbers are small, attendance must be compulsory in classes and tutorials.

2. Case of methodological units (Practical work):

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

3. About transversal subjects and discoveries that do not have a tutorial or PW:

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

However, the teacher in charge of this subject can, if he wishes, let the students know that he can possibly evaluate them (ongoing) by offering them to prepare presentations, make reports, look for additional information. of the course, use free software, ask 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 indicated to them the internet link to this film) and ask them to then submit a written report or make an oral presentation of the summary of this film, etc. The improvement of these activities is left to the discretion of the teacher and the training team who are the only ones able to define the best way to take this personal work into account in the overall mark of the final exam.

In the same idea, 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 person responsible for the subject may consider continuous evaluations of the student like 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 Teaching Council.

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

4. Harmonization of continuous control:

The use of a common grid for evaluation would promote the harmonization of these practices from one teacher to another, from one department to another and from one establishment to another. It would also constitute a structuring and reassuring benchmark for students. To do this, we propose below an evaluation grid for information purposes which presents the various continuous controls making it possible to evaluate the degree of acquisition of students' skills, whether in terms of knowledge or analytical skills. and synthesis skills.

Please note that these assessments are not intended to “trap” students by imposing very difficult continuous assessments on them. On the contrary, it is a question of “honestly” evaluating the degree of assimilation of the different skills and knowledge taught to the student in complete objectivity. In the same spirit, we would benefit from promoting the contractualization of learning evaluation by specifying, for example, the success criteria and

good practices which would result in correct and precise answers to the questions. Thus, the evaluation would mainly focus on the acquired knowledge which was the subject of training by giving exercises linked to what was prepared in tutorial without forgetting, however, to evaluate the students' ability to mobilize their skills in more complex situations.

4-1 Tutorials:

Preparation of series of exercises and personal work (homework, presentations, etc.)	30%	06 points
Written questions (minimum 02 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	20%	04 points
Report (must be returned at the end of the practical 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 spirit of the LMD. A very substantial amount of weekly time has been reserved for him: approximately 50% of the total training time (see the "Overall training summary" table in this training offer).
A survey carried out by the CPND-ST among training teams across all university establishments indicated that the time relating to the student's personal work could be judiciously exploited, under good supervision of the teacher, in a manner rational and in different forms. The tasks that would then be accomplished by the 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 free will 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 work at home 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, resolve a difficult exercise, go over the proof of a theorem in detail, search for the complement of a course, use free software or a CAD-CAD tool to make applications and simulations linked to the course, etc. These activities can be evaluated, noted and registered as a bonus for the students who carry them out.

2. Mini projet de cours:

The mini course project (1 to 3 weeks) is an effective way to prepare the student for the methodology of expression, writing and documentary research. It is a means that allows him to put into practice the techniques learned in the transversal 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 for 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 test score.

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 likely to enable them to better understand the reality of the world of work and subsequently help them achieve better professional integration.
Administrative managers as well as 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. We can offer students templates to help them present their internship report properly.

4. Participation in scientific events:

In order to imbue students with a scientific spirit (mainly for higher level students), they must be guided and encouraged to participate in round tables, laboratory seminars and conferences organized within their faculty and/or establishment. It is even advisable to encourage these students to attend conferences, related to their specialty, outside their university during exhibitions, fairs and others. This activity can be evaluated, graded and recorded as a bonus for the student who completes it.

5. Use of New Information and Communication Technologies:

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

Conclusion :

The autonomy of the student, considered as a lever for success, rests largely on the personal work that they are required to do, by appropriating the resources and tools made available to them. All this must, of course, be supervised and formalized within the framework of educational monitoring and support which must be provided jointly by the university teacher and the administrative manager throughout the training course.
This autonomy will allow them to build their professional identity according to their aspirations, their abilities and their acquired knowledge or to build their academic career in the pursuit of higher studies.

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 informed and approved by the faculty or institute)

First and last name	Graduation diploma	Specialty diploma (Magister, doctorate)	Grade	subjects to teach	Signature

Visa for the department

Visa from the faculty or the institute

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

First and last name	Establishment of attachment	Graduation diploma Specialty	diploma (Magister, doctorate)	Grade	Subjects to be taught	Signature

Visa for the department

Visa from the faculty or the institute

D : Synthèse globale des ressources humaines mobilisées pour la spécialité (L3) :

Grade	Internal workforce	External workforce	Total
Professors			
Lecturers (A)			
Lecturers (B)			
Assistant Master (A)			
Assistant Master (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)**

Laboratory title:

Student capacity:

N°	esignation of the equipment	Number	Observations

B- Internship sites and in-company training: (see agreements/conventions section)

Internship location	Number of students	Duration of internship

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

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

II – Semester-year organization sheets for specialty teaching

Semester 1

Teaching unit	Subjects	Credits	Coefficient	Weekly hourly volume			Semiannual Hourly Volume (15 weeks)	Additional work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**Tutorial**	**PW**			**Continuous Control**	**Exam**
Fundamental TU Code : FTU 1.1 Credits : 18 Coefficient : 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 teaching unit Code : MTU 1.1 Credits : 9 Coefficient : 5	TP Physics 1	2	1			1h30	22h30	27h30	100%	
	TP Chemistry 1	2	1			1h30	22h30	27h30	100%	
	Computer science 1	4	2	1h30		1h30	45h00	55h00	40%	60%
	Writing methodology	1	1	1h00			15h00	10h00		100%
Discovery TU Code : DTU 1.1 Credits : 1 Coefficient : 1	Professions in Science and Technologies 1	1	1	1h30			22h30	02h30		100%
Transversal TU Code : TTU 1.1 Credits : 2 Coefficient: 2	Ethical and deontological dimension (the foundations)	1	1	1h30			22h30	02h30		100%
	Foreign language 1 (French or English)	1	1	1h30			22h30	02h30		100 %
Total semester 1		**30**	**17**	**16h00**	**4h30**	**4h30**	**375h00**	**375h00**		

Semester 2

Teaching unit	Subjects	Credits	Coefficient	Weekly hourly volume			Semiannual Hourly Volume (15 weeks)	Additional work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**Tutorial**	**PW**			Titled	**Examen**
Fundamental TU Code : FTU 1.2 Crédits : 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 TU Code : MTU 1.2 Credits : 9 Coefficient : 5	TP Physics 2	2	1			1h30	22h30	27h30	100%	
	TP Chemistry 2	2	1			1h30	22h30	27h30	100%	
	Computer science 2	4	2	1h30		1h30	45h00	55h00	40%	60%
	Presentation methodology	1	1	1h00			15h00	10h00		100%
Discovery TU Code : DTU 1.2 Credits : 1 Coefficient : 1	Profession in science and technologies 2	1	1	1h30			22h30	02h30		100%
Transversal TU Code : TTU 1.2 Credits : 2 Coefficient : 2	Foreign language 2 (French and/or English)	2	2	3h00			45h00	05h00		100 %
Total semester 2		**30**	**17**	**16h00**	**4h30**	**4h30**	**375h00**	**375h00**		

Semester 3

Teaching unit	Subjects	Credits	Coefficient	Weekly hourly volume			Semiannual Hourly Volume (15 weeks)	Additional work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**Tutorial**	**PW**			Titled	**Examen**
Fundamental TU Code : FTU 2.1.1 Crédits : 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 TU Code : FTU 2.1.2 Credits : 8 Coefficient : 4	Fluid mechanics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Rational mechanics	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological TU Code : MTU2.1 Credits : 9 Coefficient : 5	Probability and statistics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Computer science 3	2	1			1h30	22h30	27h30	100%	
	Technical drawing	2	1			1h30	22h30	27h30	100%	
	PW Waves and vibrations	1	1			1h00	15h00	10h00	100%	
Discovery TU Code : DTU 2.1 Credits : 2 Coefficient: 2	Core technology	1	1	1h30			22h30	02h30		100%
	Metrology	1	1	1h30			22h30	02h30		100%
Transversal TU Code : TTU2.1 Credits : 1 Coefficient : 1	Technical English	1	1	1h30			22h30	02h30		100%
Total semester 3		**30**	**17**	**13h30**	**7h30**	**4h00**	**375h00**	**375h00**		

Semester 4

Teaching unit	Subjects	Credits	Coefficient	Weekly hourly volume			Semiannual Hourly Volume (15 weeks)	Additional work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**Tutorial**	**PW**			Titled	**Examen**
Fundamental TU **Code : FTU 2.2.1 Credits : 6 Coefficient : 3**	Thermodynamics 2	4	2	1h30	1h30		45h00	55h00	40%	60%
	Mechanical manufacturing	2	1	1h30			22h30	27h30		100%
Fundamental TU **Code : FTU 2.2.2 Credits : 8 Coefficient : 4**	Mathematics 4	4	2	1h30	1h30		45h00	55h00	40%	60%
	Numerical methods	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological TU **Code : MTU 2.2.3 Credits : 4 Coefficient : 2**	Resistance of materials	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological TU **Code : MTU 2.2 Credits : 9 Coefficient : 5**	Computer Assisted drawing	2	1			1h30	22h30	27h30	100%	
	Fluid mechanics TP	2	1			1h30	22h30	27h30	100%	
	PW Numerical methods	2	1			1h30	22h30	27h30	100%	
	PW Resistance of materials	1	1			1h00	15h00	10h00	100%	
	PW Mechanical Manufacturing	2	1			1h30	22h30	27h30	100%	
Discovery TU **Code : DTU 2.2 Crédits : 2 Coefficients : 2**	Industrial electricity	1	1	1h30			22h30	02h30		100%
	Materials sciences	1	1	1h30			22h30	02h30		100%
Transversal TU **Code : TTU 2.2 Credits : 1 Coefficient : 1**	Expression, information and communication techniques	1	1	1h30			22h30	02h30		100%
Total semester 4		**30**	**17**	**12h00**	**6h00**	**7h00**	**375h00**	**375h00**		

Semester 5

Teaching unit	Subjects	Credits	Coefficient	Weekly hourly volume			Semiannual Hourly Volume (15 weeks)	Additional work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**Tutorial**	**PW**			Titled	**Examen**
Fundamental TU Code : FTU 3.1.1 Crédits : 10 Coefficients : 5	Fluid Mechanics 2	6	3	3h00	1h30		67h30	82h30	40%	60%
	Heat transfer 1	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental TU Code : FTU 3.1.2 Credits : 8 Coefficient : 4	Turbomachines 1	4	2	1h30	1h30		45h00	55h00	40%	60%
	Energy conversion	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological TU Code : MTU3.1 Crédits : 9 Coefficients : 5	PW Heat transfer	2	1			1h30	22h30	27h30	100%	
	PW Turbomachines 1	2	1			1h30	22h30	27h30	100%	
	PW Energy conversion	2	1			1h30	22h30	27h30	100%	
	Measurement and instrumentation	3	2	1h30		1h00	37h30	37h30	40%	60%
Discovery TU Code : DTU 3.1 Credits : 2 Coefficient : 2	Servicing and regulation	1	1	1h30			22h30	02h30		100%
	Concept of machine elements	1	1	1h30			22h30	02h30		100%
Transversal TU Code : TTU 3.1 Credits : 1 Coefficient : 1	Environment and Sustainable Development	1	1	1h30			22h30	02h30		100%
Total semester 5		**30**	**17**	**12h00**	**6h00**	**7h00**	**375h00**	**375h00**		

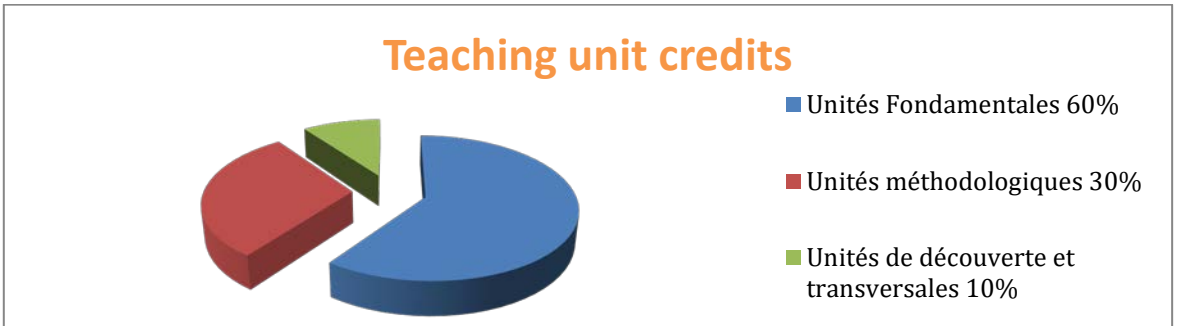
Semester 6

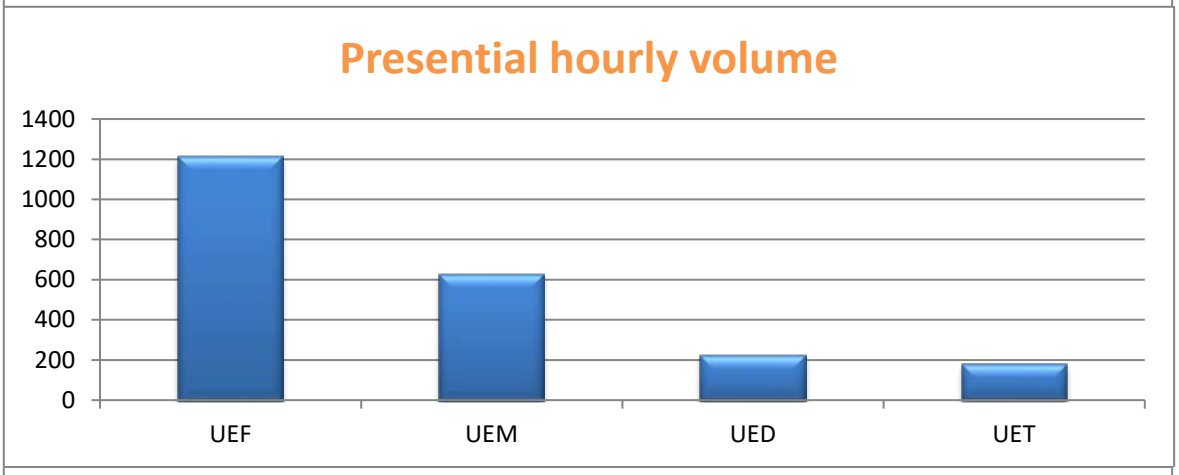
Teaching unit	Subjects	Credits	Coefficient	Weekly hourly volume			Semiannual Hourly Volume (15 weeks)	Additional work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**Tutorial**	**PW**			Titled	**Examen**
Fundamental FTU Code : UEF 3.2.1 Credits : 10 Coefficient : 5	Turbomachines 2	6	3	3h00	1h30		67h30	82h30	40%	100%
	Internal combustion engines	4	2	1h30	1h30		45h00	55h00	40%	100%
Fundamental FTU Code : UEF 3.2.2 Credits : 8 Coefficient : 4	Refrigeration machines and heat pumps	4	2	1h30	1h30		45h00	55h00	40%	100%
	Heat transfer 2	4	2	1h30	1h30		45h00	55h00	40%	100%
Methodological TU Code : MTU 3.2 Credits : 9 Coefficient : 5	End of Cycle Project	4	2			3h00	45h00	55h00	100%	
	PW Refrigeration machines and heat pumps	2	1			1h30	22h30	27h30	100%	
	PW Internal combustion engines	1	1			1h00	15h00	10h00	100%	
	Regulation and control PW	2	1			1h30	22h30	27h30	100%	
Discovery TU Code : DTU 3.2 Credits : 2 Coefficient : 2	Renewable energies	1	1	1h30			22h30	02h30		100%
	Cryogenics	1	1	1h30			22h30	02h30		100%
Transversal TU Code : TTU 3.2 Credits : 1 Coefficient : 1	Entrepreneurship and business management	1	1	1h30			22h30	02h30	100%	
Total semestre 6		**30**	**17**	**12h00**	**6h00**	**7h00**	**375h00**	**375h00**		

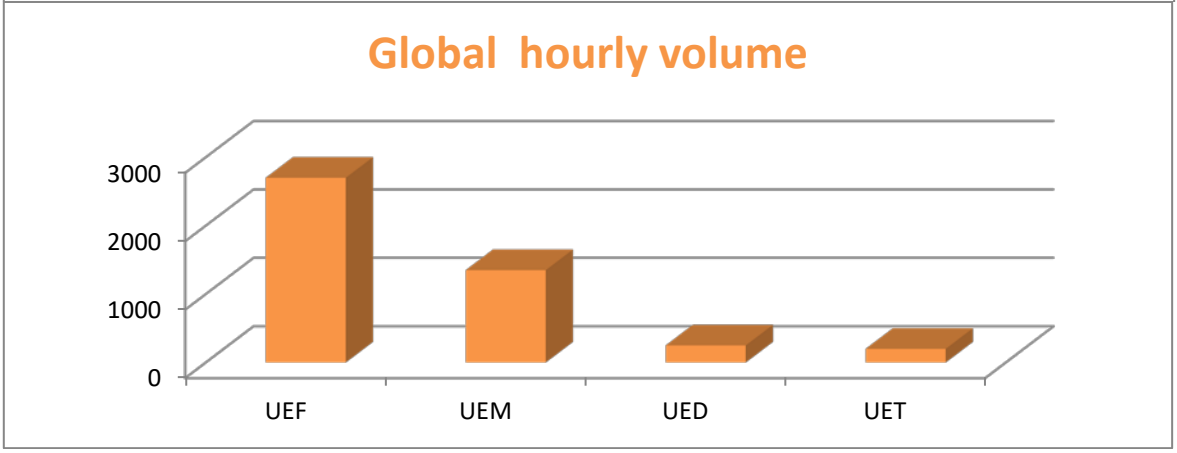
The evaluation methods presented in these tables are given for information purposes only; the establishment's training team may suggest other weightings.

Overall summary of the training:

VH \ TU	FTU	MTU	DTU	TTU	Total
Course	720h00	120h00	225h00	180h00	1245h00
Ttutorial	495h00	22h30	---	---	517h30
PW	---	487h30	---	---	487h30
Personal work	1485h00	720h00	25h00	20h00	2250h00
other (explain, list,)	---	---	---	---	---
Total	2700h00	1350h00	250h00	200h00	4500h00
Credits	108	54	10	8	180
% in credits for each TU	60 %	30 %	10 %		100 %







III - Detailed program by subject

Semester: 3
Teaching unit: FTU 2.1.1
Subject 1: Mathematics 3
SHV: 67h30 (Course: 3h00, tutorial: 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 convergence conditions as well as the different types of convergence.

Recommended prior knowledge

Mathematics 1 and Mathematics 2

Content:

Chapter 1: Simple and multiple integrals **3 weeks**
1.1 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 weeks**
2.1 Integrals of functions defined on an unbounded interval. 2.2 Integrals of functions defined on a bounded interval, infinite at one of the ends.

Chapter 3: Differential equations **2 weeks**
3.1 Reminder of ordinary differential equations. 3.2 Partial differential equations. 3.3 Special functions.

Chapter 4: series **3-week**
4.1 Numerical series. 4.2 Sequences and series of functions. 4.3 Integer series, Fourier series.

Chapter 5: Fourier Transformation **3 weeks**
5.1 Definition and properties. 5.2 Application to the resolution of differential equations.

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

Evaluation method:

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

References:

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

Semester: 3
Teaching unit: FTU 2.1.1
Subject 2:Waves and Vibrations
SHV: 45h00 (Course: 1h30, Tutorial: 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

Content :

Preamble *: This subject is divided into two parts, the Waves part and the Vibrations part, which can be approached independently of the other. In this regard and due to the consistency of this subject in terms of content, it is advisable to approach this subject in this order: Waves and then Vibrations for students in the Electrical Engineering sectors (Group A). While for students of Groups B and C (Civil Engineering, Mechanical Engineering and Process Engineering), it is wise 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. In addition, the teacher is asked to go over all the parts of the course, which require demonstrations or theoretical developments, and to focus only on the application aspects. Furthermore, demonstrations can be the subject of auxiliary work to be asked of students as activities within the framework of the student's personal work. On this subject, consult the paragraph ''G- Student evaluation through continuous assessment and personal work'' present in this training offer.*

Part A: Vibration

Chapter 1: Introduction to Lagrange equations **2 weeks**

1.1 Lagrange equations for a particle
1.1.1 Lagrange equations
1.1.2 Case of conservative systems
1.1.3 Case of speed-dependent friction forces
1.1.4 Case of an external force depending on time
1.2 System with several degrees of freedom.

Chapter 2: Free oscillations of systems at a degree offreedom **2 weeks**

2.1 Undamped oscillations
2.2 Free oscillations of damped systems

Chapter 3: Forced oscillations of systems with one degree of freedom **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 systems with two degrees of freedom **1 week**

4.1 Introduction
4.2 Systems with two degrees of freedom

Chapter 5: Forced oscillations of systems with two degrees of freedom 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 2 weeks
1.1 General and basic definitions
1.2 Propagation equation
1.3 Solution of the propagation equation
1.4 Sinusoidal traveling wave
1.5 Superposition of two progressive sinusoidal waves

Chapter 2: Vibrating strings 2 weeks
2.1 Wave equation
2.2 Harmonic traveling waves
2.3 Free oscillations of a string of finite length
2.4 Reflection and transmission

Chapter 3: Acoustic waves in fluids 1 week
3.1 Wave equation
3.2 Speed of sound
3.3 Sinusoidal traveling wave
3.4 Reflection-Transmission

Chapter 4: Electromagnetic waves 2 weeks
4.1 Wave equation
4.2 Reflection-Transmission
4.3 Different types of electromagnetic waves

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

References:

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

Semester :*3*
Teaching unit: FTU 2.1.2
Subject 1: Fluid mechanics
SHV: 45h00 (Course: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objective:

Introduce the student to the field of fluid mechanics, fluid statics will be detailed in the first part. Then in the second part, the study of the movement of inviscid fluids will be considered at the end it is the movement of the real fluid, which will be studied.

Recommended prior knowledge:

Content

Chapter 1: Properties of fluids **3 weeks**

1. Physical definition of a fluid: States of matter, divided matter (dispersion suspensions, emulsions)
2. Perfect fluid, real fluid, compressible fluid and incompressible fluid.
3. Density, density
4. Rheology of a fluid, Viscosity of fluids, surface tension of a fluid

Chapter 2: Fluid Statics **4 weeks**

1. Definition of pressure, pressure at a point of a fluid
2. Fundamental law of fluid statics
3. Level surface
4. Pascal's theorem
5. Calculation of pressure forces: Flat plate (horizontal, vertical, oblique), center ofthrust, static pressure measuring instruments, pressure measurementatmospheric, barometer, Torricelli's law
2. Pressure for superimposed immiscible fluids

Chapter 3 Dynamics of perfect incompressible fluids **4 weeks**

1. Permanent flow
2. Continuity equation
3. Mass flow and volume flow
4. Bernouilli's theorem, cases without work exchange and with work exchange
5. Applications to flow and speed measurements: Venturi, Diaphragms, tubesPitot…
6. Euler's theorem

Chapter 4: Dynamics of real incompressible fluids **4 weeks**

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

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

References:

(Selon la disponibilité de la documentation au niveau de l'établissement, Sites internet...etc.)

1- Fundamentals of fluid mechanics 6th Edition, 2009, BR Munson, DF Young TH Okiishi, WW Huebsch6th Edition John Wiley & Sons
2- Fluid mechanics, YA Cengel - 2010 - Tata McGraw-Hill Education
3- Fluid Mechanics Frank M. White Fourth Edition 2003 McGraw-Hill
4- Mécanique des fluides et hydraulique 2ème édition, Ronald v. Giles, Jack B Evett, Cheng Liu, McGraw-Hill
5- S. Amiroudine, J. L. Battaglia, 'Mécanique des fluides Cours et exercices corrigés'Ed. Dunod
6- R. Comolet, 'Mécanique des fluides expérimentale', Tome 1, 2 et 3, Ed. Masson et Cie.
7- R. Ouziaux, 'Mécanique des fluides appliquée', Ed. Dunod, 1978
8- B. R. Munson, D. F. Young, T. H. Okiishi, 'Fundamentals of fluid mechanics', Wiley & sons. R. V. Gilles, 'Mécanique des fluides et hydraulique : Cours et problèmes', Série Schaum, Mc Graw Hill, 1975.

Semester: 3
Teaching unit: FTU2.1.2
Subject 2: Rational mechanics
SHV: 45h00 (Course: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The student will be able to understand the nature of a problem (static, kinematic or dynamic) in solid mechanics; he will have the tools allowing him to solve the problem within the framework of classical mechanics. This subject constitutes a prerequisite for the subjects RDM and analytical mechanics.

Recommended prior knowledge

The student must first assimilate the physics subject 1, which deals with the mechanics of the point. In addition, mathematics subject 2 includes essential tools.

Content:

Chapter 1: Mathematical reminders (elements of vector calculation). 1 week

Chapter 2: General and basic definitions 2 weeks

2.1 Definition and physical meaning of force
2.2 Mathematical representation of force
2.3 Force operations (composition, decomposition, projection)
2.4 Type of force: point, linear, surface, volume
2.5 Classification of forces: internal forces, external forces.
2.6 Mechanical models: the material point, the solid body

Chapter 3: Static. 3 weeks

3.1 Axioms of statics
3.2 Connections, supports and reactions
3.3 Axiom of connections
3.4 Equilibrium conditions:
3.4.1 Contributing forces
3.4.2 Parallel forces
3.4.3 Plane forces

Chapter 4: kinematics of the rigid solid. 3 weeks

4.1 Brief reminders of the kinematic quantities for a material point.
4.2 Solid body kinematics
4.2.1 Translation movement
4.2.2 Rotational movement around a fixed axis
4.2.3 Plane movement
4.2.4 Compound movement.

Chapter 5: Mass geometry. 3 weeks

5.1 Mass of a hardware system
5.1.1 Continuous system
5.1.2. Discreet system
5.2 Integral formulation of the center of mass
5.2.1. Definitions (linear, surface and volume cases)
5.2.2 Discrete formulation of the center of mass
5.2.3 GULDIN theorems
5.3. Moment and product of inertia of solids
5.4. Inertia tensor of a solid
5.4.1 Special cases
5.42 Main axes of inertia
5.5. Huyghens' theorem
5.6. Moment of inertia of solids relative to any axis.

Chapter 6: Dynamics of the rigid solid. **3 weeks**
6.1 Brief reminders of dynamic quantities for a material point.
6.2 Element of rigid body kinetics:
6.2.1 Quantity of movement
6.2.2 Angular momentum
6.2.3 Kinetic energy
6.3 Dynamics equation for a solid body
6.4 Angular momentum theorem
6.5 Kinetic energy theorem
6.6 Applications:
6.6.1 Case of pure translation
6.6.2 Case of rotation around a fixed axis
6.6.3 Combined case of translation and rotation.

Evaluation method:continuous control: 40%; Exam: 60%.

References:
(Selon la disponibilité de la documentation au niveau de l'établissement, Sites internet...etc.)

1. Éléments de Mécanique rationnelle. S. Targ. Editions Mir Moscou
2. Mécanique à l'usage des ingénieurs. STATIQUE. Edition Russell. Ferdinand P. Beer
3. Mécanique générale. Cours et exercices corrigés. Sylvie Pommier. Yves Berthaud. DUNOD.
4. Mécanique générale - Théorie et application, Editions série. MURAY R. SPIEGEL schaum, 367p.
5. Mécanique générale – Exercices et problèmes résolus avec rappels de cours, Office des publications Universitaires, Tahar HANI 1983, 386p.

Semester: 3
Teaching unit: MTU 2.1
Subject 1: Probability and Statistics
SVH: 45h00 (Lecture: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient : 2

Objectives of the subject

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

Recommended prior knowledge

Mathematics 1 and Mathematics 2

Content:

Part A: Statistics

Chapter 1:Basic definitions (1 week)

1. Concepts of population, sample, variables, modalities
2. Different types of statistical variables: qualitative, quantitative, discrete, continuous.

Chapter 2: One-variable statistical series (3 weeks)

1. Number, Frequency, Percentage.
2. Cumulative number, Cumulative frequency.
3. Graphical representations: bar chart, circular chart, bar chart. Polygon of numbers (and frequencies). Histogram. Cumulative curves.
4. Position characteristics
5. Dispersion characteristics: extent, variance and standard deviation, coefficient of variation.
6. Shape characteristics.

Chapter 3: Statistical series in two variables (3 weeks)

1. Data tables (contingency table). A cloud of dots.
2. Marginal and conditional distributions. Covariance.
3. Linear correlation coefficient. Regression line and Mayer line
4. Regression curves, regression corridor and correlation ratio.
5. Functional fit.

Part B: Probabilities

Chapter 1:Combinatorial Analysis (1 week)

1. Arrangements
2. Combinations
3. Permutations.

Chapter 2: Introduction to Probability (2 weeks)

1. Algebra of events
2. Definitions
3. Parabolized spaces
4. General probability theorems

Chapter 3: Conditioning and independence (1 week)

1. Packaging,
2. Independence,
3. Bayes formula**.**

Chapter 4: Random variables (1 week)

1. Definitions and properties,
2. Distribution function,
3. Mathematical expectation,
4. Covariance and moments.

Chapter 5: Usual discrete and continuous probability laws 3 weeks
Bernoulli, binomial, Poisson, ...; Uniform, normal, exponential,...
Evaluation method: Continuous control: 40%; Exam: 60%.

References:

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

Semester:*3*
Teaching unit: MTU 2.1
Subject 1: Computer Science 3
SVH: 23h30 (PW: 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 digital methods in S4.

Recommended prior knowledge
The basics of programming acquired in computer science 1 and 2

Content:

PW 1: Presentation of a scientific programming environment
(Matlab, Scilab, etc.) 1 week
PW 2: Script files and Types of data and variables 2 weeks
PW 3: Reading, displaying and saving data 2 weeks
PW 4: Vectors and matrices 2 weeks
PW 5: Control instructions (for and while loops, if and switch instructions) 2 weeks
PW 6: Function files 2 weeks
PW 7: Graphics (Management of graphic windows, 2-week plot
PW 8: Using toolbox 2 weeks

Evaluation mode: Continuous control: 100%.

References:
(Selon la disponibilité de la documentation au niveau de l'établissement, Sites internet...etc.)
1- Informatique: Programmation et simulation en Scilab 2014 - Auteurs : Arnaud Bégyn, Jean-Pierre Grenier, Hervé Gras.

2- Scilab : De la théorie à la pratique - I. Les fondamentaux. Livre de Philippe Roux 2013.

Semester:*3*
Teaching unit: MTU 2.1
Subject 1: Technical drawing
SHV: 23h30 (PW1h30)
Credits: 2
Coefficient: 1

Teaching objectives

This teaching will allow students to acquire the principles of representing parts in industrial drawing. Even more, this subject will allow the student to represent and read the plans.

Recommended prior knowledge (brief description of the knowledge required to be able to follow this course – Maximum 2 lines).

In order to follow this course, basic knowledge of the general principles of drawing is required.

Content:

Chapter 1: General. 2 weeks

1.1 Usefulness of technical drawings and different types of drawings.
1.2 Drawing materials.
1.3 Standardization (Types of lines, Writing, Scale, Drawing format and folding,cartridge, etc.).

Chapter 2: Elements of descriptive geometry 6 Weeks

2.1 Notions of descriptive geometry.
2.2 Orthogonal projections of a point - Outline of a point - Orthogonal projectionsof a straight line (any and particular) - Sketch of a straight line - Traces of a straight line -
Projections of a plan (Any and particular positions) - Traces of a plan.
2.3 Views: Choice and arrangement of views – Rating – Slope and conicity – Determination ofthe 3rd view from two given views.
2.4 Method of executing a drawing (layout, 45° straight line, etc.)
Application exercises and evaluation (PW)

Chapter 3: Perspectives 2 Weeks

Different types of perspectives (definition and purpose).
Application exercises and evaluation (PW).

Chapter 4: Cuts and Sections 2 Weeks

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

Chapter 5: **2 Week Rating**

5.1 General principles.

5.2 Rating, tolerance and adjustment.

Application exercises and evaluation (PW).

Chapter 6: Concepts on definition and overall drawings and parts lists. **1 week**

Application exercises and evaluation (PW).

Evaluation method: Continuous control: 100%.

References:

(Selon la disponibilité de la documentation au niveau de l'établissement, Sites internet...etc.)

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

Recommendation: A large part of the practical work should be in the form of personal work at home.

Semester :*3*
Teaching unit: MTU 2.1
Subject 1: PW Waves and Vibrations
SHV: 15h00 (PW1h00)
Credits: 1
Coefficient: 1

Teaching objectives

The objectives assigned by this program concern the initiation of students to put 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 material:

PW.1 Mass – spring
PW.2 Simple pendulum
PW.3 Torsion pendulum
PW.4 oscillating electric circuit in free and forced regime
PW.5 Coupled pendulums
PW.6 Transverse oscillations in vibrating strings
PW.7 Groove pulley according to Hoffmann
PW.8 Electromechanical systems (The electrodynamic loudspeaker)
PW.9 Pohl's pendulum
PW.10 Propagation of longitudinal waves in a fluid.

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

Evaluation method:

Continuous control: 100%.

References:

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

Semester: 3
Teaching unit: DTU 2.1
Subject 1: Basic technology
SHV: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

This teaching will allow students to acquire knowledge on the processes for obtaining and manufacturing parts and their assembly techniques.

Recommended prior knowledge

Content

Chapter 1: Materials **3 Weeks**

1.1.Metals and alloys and their designations
1.2 Plastic materials (polymers)
1.3 Composite materials
1.4 Other materials

Chapter 2: Processes for obtaining parts without material removal4 Weeks

2.1 Casting, Forging, stamping, Rolling, Wire drawing, extrusion…. Etc
2.2 Cutting, bending and stamping, etc.
2.3 Sintering and powder metallurgy
2.4 Profiles and Pipes (steel, aluminum);
- Workshop visits.

Chapter 3: Processes for obtaining parts by material removal 4 Weeks

Turning, milling, drilling; adjustment, etc.
- Workshop visits and demonstrations.

Chapter 4: Assembly Techniques **4 Weeks**

- Bolting, riveting, welding, etc.

Evaluation method: Exam: 100%.

References:

(Selon la disponibilité de la documentation au niveau de l'établissement, Sites internet...etc.)

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

Semester: 3
Teaching unit: DTU 2.1
Subject 2: Metrology
SHV: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

Teach the student the precision criteria for manufacturing and assembling parts; know and know how to choose, in different cases, the methods and means of controlling and measuring the dimensions and manufacturing defects of mechanical parts.

Recommended prior knowledge

Trigonometry, optical and other.

Content

Chapter 1: General information on metrology **2 Weeks**

1.1 Definition of the different types of metrology (scientific, so-called laboratory, legal,industrial);
1.2 Metrological vocabulary, definition;
1.3 National and international metrology institutions.

Chapter 2: The international SI measurement system **3 Weeks**

2.1 Basic quantities and their units of measurement;
2.2 Additional sizes;
2.3 Derived quantities.

Chapter 3: Metrological characteristics of measuring devices **6 Weeks**

3.1 Error and uncertainty (Accuracy, precision, fidelity, repeatability, reproducibility of ameasuring device
3.2 Classification of measurement errors
3.2.1 Gross value;
3.2.2 Systematic error;
3.2.3 Corrected gross value.
3.3 Accidental errors
3.3.1 Random errors;
3.3.2 Spurious errors;
3.3.3 Estimated systematic errors.
3.4 Confidence interval;
3.5 Technical uncertainty;
3.6 Total measurement uncertainty;
3.7 Complete measurement result;
3.8 Identification and interpretation of specifications of a definition drawing for the purpose ofcontrol;
3.9 Basic concepts of calibers, gauges and simple measuring instruments.

Chapter 4: Measurement and control **4 Weeks**

4.1 Direct measurement of lengths and angles (use of ruler, caliper,micrometer and protractor);
4.2 Indirect measurement (use of comparator, gauge blocks);
4.3 Dimensions control (use of buffers, jaws, etc.);
4.4 Measuring and control machines used in mechanical workshops (use ofpneumatic comparator, profile projector and roughness meter.

Evaluation method: Exam: 100%.

References:
(Selon la disponibilité de la documentation au niveau de l'établissement, Sites internet...etc.)

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

Semester:*3*
Teaching unit: DTU 2.1
Subject 1: Technical English
VHS: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

This course must allow the student to have a language level where he will be able to use a scientific document and talk about his specialty and sector in English at least with ease and clarity.

Recommended prior knowledge

English 1 and English 2

Content

- Oral comprehension and expression, acquisition of vocabulary, grammar...etc.
- Nouns and adjectives, comparisons, following and giving instructions, identifying things.
- Use of numbers, symbols, equations.
- Measurements: Length, surface, volume, power...etc.
- Describe scientific experiments.
- Characteristics of scientific texts.

Evaluation method: Exam: 100%.

References:

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

Semester: 4
Teaching unit: UEF 2.2.1
Subject 2: Thermodynamics 2
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

Fix the general ideas of thermodynamics and implementhighlights their uses in engineering sciences. The objective is to be able to analyze energy systems by using the prerequisites of the first year and to show what must be implemented for the study of water vapor and introduce the study of the cycles of thermal and refrigeration machines.

Recommended prior knowledge

Thermodynamics of S2, Mathematics ofbase.

Content of the material:

Chapter 1: Reminders on the Basic Concepts of Thermodynamics 1 week

Reminder of the three principles of thermodynamics.

Chapter 2: Thermodynamic Properties of Pure Substances 2 weeks

State Diagrams (T-s Diagram, p-h Diagram, h-s Diagram), Thermodynamic Tables (Tables of properties at saturation, Tables of properties of superheated steam), Equations of State (Equation of state of an ideal gas, Developments of the virial, Van Der Waals Equation, Equations of State derived from the Van Der Waals equation, Reduced Variables and Law of Corresponding States, Semi-Empirical Equations of State)

Chapter 3: Thermodynamics of Vapors and Humid Air 2 weeks

Thermodynamics of Vapors (Phase Change of a Pure Body, Calculation of State Variables, Vapor Content, Thermodynamic Diagrams and Tables), Humid Air (Characterization of humid air, Mollier Diagram, Elementary operations on air humid).

Chapter 4: Gas Compression 2 weeks

Classification of Compression Machines, Isentropic Compression, Polytropic Compression, Piston Compressors, Rotary Volumetric Compressors (Definitions).

Chapter 5: Gas Relaxation 2 weeks

Expansion Machines, Adiabatic Expansion, Non-adiabatic Expansion, Work, Yield and Power Produced, Rotary Volumetric Compressor

Chapter 6: Engine Cycles 3 weeks

Carnot cycle, Otto cycle, Diesel cycle, Brayton cycle, Steam turbines, Rankine cycle (Reheating cycle, Withdrawal cycle, Cogeneration).

Chapter 7: Refrigeration Cycles 3 weeks

Gas refrigeration cycle, Single stage vapor compression cycle, Refrigerants, Cold room thermal load, Twostage compression cycles, Cascade cycles, Heat pumps

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

References:

1- Y. CENGEL, M. A. BOLES, 'Thermodynamique, une approche pragmatique', Edition De Boeck, la Chenelière, 2008 . Traduit de l'anglais par M. Lacroix de 'Thermodynamics, an Engineering approach'.
2- AndreHOUBERECHTSLa thermodynamique technique, tomes 1 et 2
3- SONNTAG et VAN WYLEN, 'Thermodynamique et applications', traduit de l'anglais, Fundamentalsof classical thermodynamics' ed. McGraw Hill.
4- G. BRUHAT, Revue et augmenté par A. KASTLER, 'Thermodynamique', Edition 6, Masson & Cie.
5- R. Kling, 'Thermodynamique et applications', Edition Technip.
6- M. J. MORAN and HOWARD M. SHAPIRO, Fundamentales of engineering Thermodynamic', J. Wyley& sons editors, 2006.
7- RAPIN-JACQUARDInstallations frigorifiques (technologie), Edition Dunod; 2004
8- J. P. PEREZ 'Thermodynamique: Fondements et applications', Dunod, Paris 2001.

Semester: 4
Teaching unit: FTU2.2.1
Subject 1: Mechanical manufacturing
VHS: 22h30 (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Give the student knowledge on the manufacturing techniques of products in individuals mechanical products.

Recommended prior knowledge:

Basic technology, material sciences,

Content:

I- Theory of metal cutting

1.1 Cutting materials (1 week)
1.2 Geometry of cutting tools (1 week)
1.3 Chip formation mechanism (1 week)
1.4 Cutting efforts (1 week)
1.5 Heating (Cutting temperature)
1.6 Damage to cutting tools (1 week)
1.7 Methodology for choosing cutting parameters (1 week)

II- Machine tool technologies

2.1 Cutting movements (1 week)
2.2 Characterization of a machine tool (Main organs) (2 weeks)
- Pin
- Building
- Slides

2.3 Drive chains (6 weeks)
- Movement transmission mechanisms
- Lathes, planers and vice-filers, drilling machines, milling machines, broaching machines, cylindrical and surface grinding machines, etc...

Evaluation method: Exam: 100%.

References:

1- Techniques de l'ingénieur 2000 B.BM.BT. Janvier 2000 Printed in France by Imprimerie Strasbourgeoise Schiltighein- ISTRAIN
2- Roger Bonetto les ateliers flexibles de production 2ème édition Hermes 1987-Paris
3- G. Levallant ; M.Dessoly ; P.Géodossi ; P.Leroux ; J.C.Moulet ; G.Poulachon ; P.Robert Usinage par enlèvement de copeaux- de la technologie aux applications industrielles Ensam. Edition Eyrolles N° 7211- Juin 2005 Paris
4- Eléments de Fabrication Edition Ellipses. Copyright 1995 Paris

5- Michel Ahby, Choix de Matériaux en Conception Mécanique ; Dunod, 1999
6- Claude Hazard, La Commande Numérique des M O, édition Foucher, Paris 1984
7- Gonzalez, CN par calculateur, édition Foucher Paris 1985.
8- Philippe DEPEYRE, Cours « Fabrication mécanique », Faculté des Sciences et Technologies, Université de la Réunion, Année 2004-2005

Semester: 4
Teaching Unit: FTU 2.2.2
Subject: Mathematics 4
VHS: 45h00 (Course: 1h30, Tutorial: 1h30)
Credit: 4
Coefficient: 2

Teaching objectives:

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

Recommended prior knowledge:

Mathematics 1, Mathematics 2 and Mathematics 3.

Content of the material:

Functions with complex variables and Special Functions

Chapter 1: Holomorphic functions. Cauchy Riemann conditions 3 weeks

Chapter 2: Entire series 3 weeks

Convergence radius. Convergence domain. Development in whole series. Analytical Functions.Laurent series and development in Laurent series

Chapter 3: Cauchy theory 3 weeks

Cauchy's theorem; Cauchy formulas. Singular point of functions, general method for calculating complex integrals

Chapter 4: Applications 4 weeks

Equivalence between holomorphy and Analyticity. Maximum Theorem. Liouville's theorem. Rouche's theorem. Residue Theorem. Calculation of integrals using the Residue method.

Chapter 5: Special Functions 2 weeks

Special Euler functions: Gamma, Beta functions, applications to integral calculations

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Références bibliographiques:

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

Semester: 4
Teaching unit: FTU2.2.2
Subject 1: Numerical methods
SHV: 45h00(Course: 1h30,Tutorial: 1h30)
Credits: 4
Coefficient : 2

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

Recommended prior knowledge:
Math1, Math2, Computer Science1 and Computer Science 2

Content of the material:

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 (2 weeks)

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

Chapter 3 Function Approximation:(2 weeks)

1. Approximation method and root mean square.
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 method,
4. Quadrature formulas.

Chapter 5: Resolution of ordinary differential equations (2 weeks) (initial condition or Cauchy problem).

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

Chapter 6: Direct solution method for systems of linear equations (2 weeks)

1. Introduction and definitions,
2. Gauss method and rotation,
3. LU factorization method,
4. ChoeleskiMM factorization method,
5. Thomas algorithm (TDMA) for three-diagonal 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.

Evaluation method:
Continuous monitoring: 40%; Exam: 60%.

References:

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

Semester: 4
Teaching Unit: FTU 2.2.3
Material: Resistance of materials
SHV: 45h00, (Course: 1h30, Tutorial: 1h30)
Credit: 4
Coefficient: 2

Teaching objectives:

Know the methods of calculating the resistance of construction elements and determine the variations in the shape and dimensions (deformations) of the elements under the action of loads.

Recommended prior knowledge:

Function analysis; rational mechanics.

Content:

Chapter 1 : INTRODUCTIONS AND GENERAL **(2 weeks)**

1.1 Goals and Assumptions of Material Strength
1.2 Classification of solids (beam, plate, shell)
1.3 Different types of loading
1.4 Connections (supports, fittings, ball joints)
1.5 General principle of equilibrium – Balance equations
1.6 Principles of cutting – Elements of reduction
1.7 Definitions and sign conventions of:
- Normal force N,
- Shear force T,
- Bending moment M

Chapter 2 : TRACTION AND COMPRESSION **(3 weeks)**

2.1 Definitions
2.2 Normal tensile and compressive stress
2.3 Elastic deformation in traction/compression
2.4 Tensile/compressive strength condition

Chapter 3 : SHEAR **(2 weeks)**

3.1 Definitions
3.2 Simple shear – pure shear
3.3 Shear stress
3.4 Elastic deformation in shear
3.5 Shear resistance condition

Chapter 4 : GEOMETRIC CHARACTERISTICS OF STRAIGHT SECTIONS **(3 weeks)**

4.1 Static moments of a straight section
4.2 Moments of inertia of a straight section
4.3 Formulas for transforming moments of inertia

Chapter 5 : TORSION **(2 weeks)**

5.1 Definitions
5.2 Tangential or sliding stress
5.3 Elastic torsional deformation
5.4 Torsion resistance condition

Chapter 6 : SIMPLE PLANE FLEXION **(3 weeks)**

6.1 Definitions and assumptions
6.2 Cutting force, bending moments
6.3 Diagram of shear forces and bending moments
6.4 Relationship between bending moment and shear force
6.5 Deformation of a beam subjected to simple bending (arrow)
6.6 Calculation of constraints and sizing

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

References:

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

Semester: 4
Teaching Unit: MTU 2.2
Subject: Computer-assisted drawing
SHV: 22h30 (PW: 1h30)
Credit: 2
Coefficient: 1

Teaching objectives:

This teaching will allow students to acquire the principles of representing parts in industrial drawing. Even more, this subject will allow the student to represent and read the plans.

Recommended prior knowledge:

Technical Drawing. .

Content of the material:

1. PRESENTATION OF THE CHOSEN SOFTWARE **(4 weeks)**
(SolidWorks, Autocad, Catia, Inventor, etc.)
1.1 Introduction and history of the DAO;
1.2 Configuration of the chosen software (interface, shortcut bar, options, etc.);
1.3 Software reference elements (software help, tutorials, etc.);
1.4 Backup of files (part file, assembly file, drawing file, backup procedure for delivery to the teacher);
1.5 Communication and interdependence between files.

2. CONCEPT OF SKETCHES **(3weeks)**
2.1 Sketching tools (point, line segment, arc, circle, ellipse, polygon, etc.);
2.2 Sketch relationships (horizontal, vertical, equal, parallel, hillside, fixed, etc.);
2.3 Dimensions of sketches and geometric constraints.

3. 3D MODELING **(3weeks)**
3.1 Concepts of planes (front plane, right plane and top plane);
3.2 Basic functions (extrusion, material removal, revolution):
3.4 Display functions (zoom, multiple views, multiple windows etc.):
3.5 Modification tools (Delete, Shift, Copy, Mirror, Adjust, Extend, Move):
3.6 Creating a sectional view of the model.

4. DESIGN OF THE 3D MODEL **(3weeks)**
4.1 Editing the plan and the title block:
4.2 Choice of views and drawing:
4.3 Object layouts and properties (hatching, dimensioning, text, tables, etc.)

5. ASSEMBLY **(2 weeks)**
5.1 Assembly constraints (parallel, coincidence, coaxial, fixed, etc.):
5.2 Production of assembly drawings:
5.3 Assembly drawing and part nomenclature:
1. Exploded view.

Evaluation method:

Continuous control: 100%.

References:

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

Semester: 4
Teaching unit: MTU2.2
Subject 2: TP Fluid mechanics
SHV: 22h30 (TP: 1:30 a.m.)
Credits:2
Coefficient: 1

Teaching objectives:
apply the different stresses studied in the module resistance of materials and determination of the characteristics of materials based on simple mechanical tests.

Recommended prior knowledge:
Resistance of materials, materials sciences.

Content:

TP No. 1: Tensile – simple compression tests
TP No. 2: Torsion test
TP No. 3: Simple bending test
TP No. 4: Resilience test
TP No. 5: Hardness test

Evaluation method:
Continuous control: 100%.

Semester: 4
Teaching Unit: MTU 2.2
Subject: PW numerical methods
SHV: 23h30 , (PW: 1h30)
Credit: 2
Coefficient: 1

Teaching objectives:

Programming of different numerical methods with a view to theirapplications 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.

Content of the material:

1. Solving nonlinear equations **(3 weeks)**
   - 1.1. Bisection method
   - 1.2. Fixed point method
   - 1.3. Newton–Raphson method
   - 1.4.
2. Interpolation and approximation **(3 weeks)**
   - 2.1. Newton interpolation
   - 2.2. Chebyshev approximation
3. Digital integrations **(3 weeks)**
   - 3.1. Rectangle Method
   - 3.2. Trapeze method
   - 3.3. Simpson method
4. Differential equations **(2 weeks)**
   - 4.1. Euler's method
   - 4.2. Runge-Kutta methods
5. Systems of linear equations **(4 weeks)**
   - 5.1. Gauss-Jordon method
   - 5.2. Crout decomposition and LU factorization
   - 5.3. Jacobi method
   - 5.4. Gauss-Seidel method

Evaluation method:

Continuous control: 100%.

References :

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

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

Semester: 4
Teaching unit: MTU2.2
Material 4:PW Material strength
SHV: 15:00 (PW: 1:00)
Credits: 1
Coefficient: 1

Teaching objectives:
apply the different stresses studied in the module resistance of materials and determination of the characteristics of materials based on simple mechanical tests.

Recommended prior knowledge:
Resistance of materials. materials sciences.

Content:

TP No. 1: Tensile – simple compression tests
TP No. 2: Torsion test
TP No. 3: Simple bending test
TP No. 4: Resilience test
TP No. 5: Hardness test

Evaluation method:
Continuous control: 100%.

Semester: 4
Teaching unit: MTU2.2
Subject 5: PW Mechanical manufacturing
SHV: 22h30 (PW: 1:30)
Credits: 1
Coefficient: 1

Teaching objectives:
apply the different machining processes.

Recommended prior knowledge:

Mechanical manufacturing and technical drawing courses.

Content:

Practical work no. 1:
Turning a cylindrical part with 2 diameters with operations
straightening and carriage

-Execution of rough and definition drawings.
-Determination of cutting regimes and development of the machining range of the part.
-Preparation of tools, machine and measuring instruments.
-Positioning, clamping of the blank, focusing and adjusting the machine.
-Performing the operations and the part.

Practical work no. 2:
Milling and drilling of a prismatic part with mainly
milling and drilling phases.

-Definition of the shape, dimensions, tolerances and surface conditions of the part (definition drawing)
-Rough drawing.
-Determination of cutting regimes and development of the machining range of the part (without the grinding phase).
-Cutting the blank.
-Preparation of tools, machine(s) and measuring instruments.
-Positioning, clamping of the blank, focusing and adjusting the machine.
-Performing operations and parts

Practical work no. 3: Plane grinding and examination of surface conditions
(Use of part from PW no. 2)

-Analysis of the rough and definition drawings of TP n°2
-Determination of grinding regimes and development of the complete machining range of the part (with the grinding phase).
-Preparation of tools, machine and instruments for measuring surface condition (roughness).
-Positioning, clamping of the blank, focusing and adjusting the machine.
-Carrying out the rectification phase and checking the surface condition.

Practical work no. 4: welding

- Preparation of parts to be assembled
- Choice of filler metal
- Creation of the weld bead
    - Cleaning and control

Evaluation method: Continuous control: 100%.

Semester: 4
Teaching unit: DTH2.2
Subject 1: Industrial electricity
SHV: 22h30 (Class: 1h30)
Credits:1
Coefficient: 1

Teaching objectives:
The objective of the program is to provide Mechanical Engineering students with a body of knowledge that is essential and necessary for the physical understanding of the essentials of electrotechnical phenomena.

Recommended prior knowledge:
Fundamental lessons in physical sciences acquired in the common core of science and technology.

Content:

Chapter 1 – Electrical circuits (4 weeks)
1.1 Introduction
1.2 Current and voltage in electrical circuits
1.3 Resistors and equivalent circuit.
1.4 Work and power
1.5 Single-phase and three-phase electrical circuits.

Chapter 2 – Magnetic circuits (3 weeks)
2.1 Magnetism and electricity
2.2 Basic laws
2.3 Magnetic materials and circuits

Chapter 3 – The Transformers (2 weeks)
3.1 Description
3.2 Equivalent circuits
3.3 Instrument transformers
3.4 Special transformers

Chapter 4 – Electrical Machines (3 weeks)
4.1 Direct current machines (shunt, separate, series excitation)
4.2 Synchronous machines
4.3 Asynchronous machines
4.4 Special machines
4.5 Connection of three-phase motors

Chapter 5 – Electrical Measurements (3 weeks)
5.1 Measurement in physics
5.2 Measurement quality – errors
5.3 Structure of digital display devices
5.4 Current and voltage measurements
5.5 Power and energy measurements
5.6Wiring diagrams of an electrical installation - Section calculation wired.

Evaluation method: Exam: 100%.

References:

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

Semester: 4
Teaching unit: DTU2.2
Subject 2: Materials science
SHV: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
This subject allows the student to know the classification of materials as well as the basic notions of crystallography; equilibrium diagrams and heat treatments

Recommended prior knowledge:
The fundamental subjects of S1 and S2.

Content:

Chapter 1: General (03 weeks)
1.1 Classification of materials:
1.1.1 Metals and alloys
1.1.2 Ceramics and glasses
1.1.3 Polymers
1.1.4 Composite materials
1.2 Areas of use
1.3 Structure of materials: amorphous materials and crystalline materials
1.4 Crystallography concepts

Chapter 2: Balance diagrams (04 weeks)
2.1 Crystallization of materials
2.1.1 Principle of crystallization and cooling curves
2.1.2 Crystallization of a pure metal
2.1.3 Crystallization of an alloy
2.2 Equilibrium diagram of two completely miscible metals
2.3 Equilibrium diagram of two partially miscible metals

Chapter 3: Iron-carbon balance diagram (04 weeks)
3.1 Characteristics of iron and carbon
3.2 Iron-carbon balance diagram
3.3 Iron-cementite equilibrium diagram
3.4 Standardized designation of steels and cast irons
3.5 Standardized designation of other alloy steels

Chapter 4: Thermal treatments and thermochemical diffusion treatment (03 weeks)
1. Heat treatments
Annealed
Tempering
Income
2. Thermochemical treatments
Cementation
Nitriding
Carbonitriding

Evaluation method: Exam: 100%.

References:

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

Semester:4
Teaching unit: TTU2.2
Subject: Expression, information and communication techniques
SHV: 22h30 (Class: 1h30)
Credits:1
Coefficient:1

Teaching objectives:

This course aims to develop the student's skills, on a personal or professional level, in the field of communication and expression techniques. It also allows the student to know the techniques, tools and methods used to facilitate communications.

Recommended prior knowledge:
Languages (Arabic; French; English)

content:

Chapter 1: Research, analyze and organize information (2 weeks)
Identify and use places, tools and documentary resources, Understand and analyze documents, Create and update documentation.

Chapter 2: Improving the ability to express (2 weeks)
Take into account the Communication situation, Produce a written message, Communicate orally, Produce a visual and audiovisual message, Improve the ability to communicate in a group.

Chapter 3: Develop autonomy, organizational and communication skills within the framework of a project approach (2 weeks)
Position yourself in a project and communication approach, Anticipate action, Implement a project: Presentation of a report of practical work (homework).

Chapter 4: ICT - Definition and Evolution (2 weeks)
Definition, Activities using ICT, Mastery of ICT skills, Evolution of ICT, Information and communication services

Chapter 5: Search, use and retrieval of information. (2 weeks)
Search directories (YAHOO, GOOGLE), Search engines, Query and search language, Retrieving and printing an HTML page, Retrieving an image, Downloading a file or software, Reading 'a local HTML file, Playback of a multimedia file saved on the Web.

Chapter 6: ICT Rights (2 weeks)
Computer crime, Media law, Electronic communications law, Electronic commerce law, Internet governance, ...

Chapter 7: Securing sensitive information, Protection of confidential data and Preservation of nuisances. (3 weeks)
Backup of important data, "Informatics and freedoms" law, Internet dangers, Computer hacking, Machine protection, Protection against viruses, Protection against cyber threats or online threats (Phishing, spam emails, spyware, malware, ransomware, viruses and

trojanhorses, man-in-the-middle attacks, etc.), Preventing data loss, Spam, Hoaxes, Cryptology, Electronic signature….

Evaluation method: Final exam: 100%.

References:

(L*ivres et polycopiés, sites internet, etc.)*

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

Semester: 5
Teaching unit: FTU 1.1
Subject 1: Fluid Mechanics 2
SHV: 67h30 (Class: 3h00; Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

This subject is a continuation of fluid mechanics 1, it focuses on fluid kinematics, analysis based on the concept of control volume and dimensional and similarity analysis.

Recommended prior knowledge:

MDF 1, Thermodynamics, Physics 1 and 2.

Content of the material:

Chapter 1. Fluid kinematics (6 Weeks)

Reference systems. Continuity equation: differential form. Concepts of volume flow and mass flow. Rotational and irrotational flows. Circulation and vorticity

Irrotational or velocity potential flows. Flat flows. Elementary potential flows. Superposition of simple flows. Graphic overlay method. Elements of complex potential theory. Elementary potential flows expressed in complex form. Method of conformal transformations

Chapter 2. Analysis based on the concept of control volume. (5 Weeks)

2.1 Conservation of mass- continuity equation. Derivation of the continuity equation. Fixed non-deformable control volume. Non-deformable control volume in motion.Deformable control volume.

2.2 Newton's second law-Linear equations of momentum and momentum of momentum. Derivation of the linear equation for momentum. Application of the linear equation of momentum. Derivation of the linear equation for momentum. Application of the linear momentum equation.

Chapter 3. Dimensional analysis and similarity (4 Weeks)

Introduction. Dimensional analysis. Similarity.Applications.

Evaluation method:

Continuous control: 40%; Exam: 60%.

References:

1. R. Comolet, « Mécanique expérimentale des fluides », Editeur Masson, 1976, Tomes I, II et III.
2. R. B. Bird, W. E. Stewart, E. N. Lightfoot, "Transport Phenomena", Wiley editor, 1960.
3. Rjucsh K. Kundu, I. M. Cohen, "Fluid Mechanics", 2nd Edition, Academic Press, 2002.
4. D. P. Kesseler and R. A. Greenkorn, "Momentum, Heat, and Mass transfer: Fundamentals", M. Dekker, 1999.
5. T. C. Papanastasiou, G. C. Georgiou and A. N. Alexandrou, "Viscous fluid flow", CRC Press LLC, 2000.
6. G. Emanuel, "Analytical Fluid, Dynamics", 2nd edition, CRC Press, 2000.

7. R. W. Fox, A. T. Mc Donald and P. J. Pritchard, “Introduction to fluid mechanics”, sixth edition, Wiley and sons editor, 2003.
8. G. K. Batchelor, FRS, “An Introduction to fluid dynamics”, Cambridge University Press.
9. Fundamentals of fluidmechanics 6theditionMunsen, Young, Okiishi, Huebsch. John Wiley& Sons, Inc. 2009.
10. Fluid Mechanics, Frank M. White University of Rhode IslandSeventh Edition Published by MC Graw-hill 2011.

Semester: 5
Teaching unit: FTU 3.1.1
Subject 2: Heat transfer 1
SHV: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

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

Recommended prior knowledge:

Thermodynamics, MDF, Mathematics.

Content:

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

Chapter 2. Basic laws of heat transfer (2 Weeks)

Chapter 3. Heat conduction (7 Weeks)

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

Chapter 4. Convective heat transfer (5 Weeks)

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

Evaluation method: continuous control: 40% ; Exam: 60%.

References:

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

Semester: 5
Teaching unit: FTU 3.1.2
Subject 1: Turbomachines 1
SHV: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Apply fluid mechanics to technical systems such as hydraulic pumps and turbines. Know how to size and install pumps. Know the origin of pump failure. Calculate, select and install different types of hydraulic turbines according to demand.

Recommended prior knowledge:

fluid mechanics 1, Thermodynamics.

Content:

Chapter 1. Definitions and general theory of turbomachines (4 Weeks)

Classification of turbomachines, General theory, Euler's theorem. Speed diagram. Height, power. Efficiency of turbomachines. Component of the energy transferred. Degree of reaction, variation of charge, degree of reaction.

Chapter 2. Push-ups (3 Weeks)

General relations, Centrifugal pumps and axial pumps, Descriptions, speed triangles, efficiencies.

Chapter 3. Similarities in turbomachines (3 Weeks)

General relations, Rateau invariants, Other coefficients, Similar operating machines, Generalization, Specific speed.

Chapter 4. Cavitation in pumps (2 weeks)

Origin and criteria of cavitation, Manifestation, Influence of different factors, Similarity of cavitation.

Chapter 5. Hydraulic turbines (3 Weeks)

The Pelton turbine, The reaction turbine, The Francis turbine, The Kaplan turbine**.**

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

References:

1. P. HENRY, « Turbomachines hydrauliques », Presses Polytechniques et Universitaires Romandes, 1992.
2. M. Sedille, « Turbomachines Hydrauliques et thermiques », Masson, 1970.
3. P. Henry, « Turbomachines hydrauliques », 1992.
4. Peng, "Fundamentals of Turbomachinery", Wiley and Sons, 2008.
5. M. Pluviose, « Ingénierie des turbomachines**,** Circuits, vibrations, effets instationnaires et des exercices résolus », génie énergétique, Ellipses 2003.

6. P. Chambadal, « La turbine à gaz », 1997.
7. R. Bidard et J. Bonnin, « Energétique et turbomachines », Eyrolles 1979.
8. L. Vivier, Turbines à vapeur et à gaz, 1965
9. M. Pluviose, « Conversion d'énergie par Turbomachines », 2009
10. J. Krysinski, « Turbomachines, théorie générale », OPU, Alger, 1986.
11. R. Bidard, J. Bonnin, « Energétique et Turbomachines », Eyrolles, Paris 1979.

A. Jaumotte, « Turbopompes centrifuges », P.U. Bruxelles, 1979.

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

Semester: 5

Teaching unit: FTU 3.1.2

Subject 2: Energy conversion

SHV: 45h00 (Class: 1h30; Tutorial: 1h30)

Credits: 4

Coefficient: 2

Teaching objectives:

Apply the concepts of thermodynamics acquired in previous years to various energy-producing or consuming machines. Search through exergy analysis for possibilities for improvement or failures in real thermodynamic systems. Energy analysis of systems using combustion.

Recommended prior knowledge:

Thermodynamics

Material content:

Chapter 1. Single Phase Power Cycles (4 Weeks)

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

Chapter 2. Two-Phase Power Cycles (4 Weeks)

Reminders about phase change. Rankine cycle. Hirn cycle. Reheat cycle. Cycle with one or more steam withdrawals. Mixed cycle (gas-capture). Steam thermal power plants. Hybrid installations (solar-gas). Cogeneration installations. Concept on nuclear power plants.

Chapter 3. Exergy and exergy analysis of thermodynamic systems (3 Weeks)

Application to gas thermal power plants and steam thermal power plants.

Chapter 4. Thermodynamics of combustion (3 Weeks)

Properties of mixtures, stoichiometric combustion, heat of formation and calorific values, adiabatic flame temperature. Chemical kinetics: Elementary reactions, chain reactions and production of free radicals, recombinations, equilibrium constants, reaction rates. Simplified combustion models, pressure dependence, partial equilibrium and quasi-steady states. Autoignition, and spontaneous ignition, effect of pressure on autoignition temperature, controlled ignition, critical heat flow for ignition.

Evaluation method:

Continuous control: 40%; Exam: 60%.

References:

1. R. E. Sonntag and J. G. Van Wylen, “Fundamentals of classical thermodynamics”, Ed. J. Wiley & Sons, 1978.
2. Kaster, « Thermodynamique 6ème édition », Masson, 1968.
3. R. kling, « Thermodynamique et application », Edition Technip.
4. M. Bertin, J. P. Faroux et J. Renault, « Thermodynamique », Dunod Université, 1981.
5. M. W. Zemansky and R.H. Ditmann, “Heat and Thermodynamic”, 7th edition, Mc Graw Hill, 1981.

6. J. P. Perez, « Thermodynamique, Fondements et applications », seconde édition, Masson, 1997.
7. S. Mc Allister, Jyh-Yuan Chen and A. Carlos Fernandez-Pello, "Fundamentals of Combustion Processes", Springer editor, 2011.
8. T. Poinsot and D. Veynante, "Theoretical and Numerical Combustion", Edwards editor, 2005.

Semester: 5
Teaching unit: MTU 3.1
Subject 1: PW Heat transfer
SHV: 22h30 (PW: 1:30)
Credits: 2
Coefficient: 1

Teaching objectives:

Practically illustrate the knowledge acquired in the heat transfer course.

Recommended prior knowledge:

Heat transfer, thermodynamics.

Content:

Plan some experiments related to heat transfer according to the means available.

Evaluation method:

Continuous control: 100%.

Semester: 5
Teaching unit: MTU 3.1
Subject 2: PW Turbomachines 1
SHV: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Practically illustrate the behavior of hydraulic type turbomachines, pumps and hydraulic turbines.

Recommended prior knowledge:

Turbomachinery.

Content:

Plan some experiments in relation to turbomachines according to the means available.

Evaluation method:

Continuous control: 100%.

Semester: 5
Teaching unit: MTU 3.1
Subject 3: PW Energy conversion
SHV: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Put the principles of energy conversion into practice on energy machines.

Recommended prior knowledge:

Energy conversion.

Material content:

Plan some experiments related to energy conversion according to the means available.

Evaluation method:

Continuous control: 100%.

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

Teaching objectives:

Acquire the different experimental and measurement techniques, particularly those used in energy. Learn to choose the right instruments and sensors to set up his own experiences. Be able to appreciate mistakes.

Recommended prior knowledge:

Thermodynamics, FM, Heat transfer, electricity…

content:

Chapter 1. Thickness and length measurements (5 weeks)

Mechanical instruments, Pneumatic instruments, Optical instruments, Error assessment.

Chapter 2. Temperature Measurements (5 Weeks)

Thermocouples, thermistors, infrared detectors, pyrometers. Calibration of thermal sensors. Errors related to thermal sensors. The choice of sensors. Automatic acquisition of measurements and acquisition cards.

Chapter 3. Measurements of flow rates, speeds and pressures (5 Weeks)

The different flow meters, The choice and errors linked to each type, Pitot, Prasil and Prandtl tubes, Hot wire and hot film anemometers, Dopler laser anemometers, PIV. Pressure measurements: Mechanical sensors, piezoelectric sensors. Electrical measurements, Signal processing, Interpretation of results, Development of experiments.

Practical work.

Depending on the means of the establishment and the availability of equipment, at least five (05) TPs must be carried out in this subject.

Evaluation method:

Continuous control: 40%; Exam: 60%.

References:

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

Semester: 5
Teaching unit: DTU 3.1
Subject 1: Concept of machine elements
SHV: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Objectifs de l'enseignement:

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

Recommended prior knowledge:

Industrial Design, Resistance of materials, Mechanical Manufacturing.

Content:

Chapter 1. Introduction (2 Weeks)
General (mechanical construction, design study, safety coefficient, standards, economy, reliability)

Chapter 2. Threaded assemblies (3 Weeks)
Screws, bolts, studs, resistance calculation (shear, matting, bending, tightening of a hyperstatic system, etc.)

Chapter 3. Gears (3 Weeks)
Cylindrical gear (straight and helical teeth), Bevel gear (straight and helical teeth), worm gear.

Chapter 4. Shafts and axes (2 Weeks)
Calculation of the preliminary diameter of axes and shafts, Verification of shafts and axes for fatigue.

Chapter 5. Motion transmission (calculation and sizing) (3 Weeks)
Plain bearings and thrust bearings, Rolling bearings and thrust bearings, Friction wheels, Belts, Chains,

Chapter 6. Couplings, clutches and brakes (2 Weeks) (2 Weeks)

Evaluation method:

Exam: 100%.

References:

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

7. J. L. FANCHON, « Guide de Mécanique », NATHAN, 2008.
8. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 1, Principes et Eco-conception, DUNOD, 2009.
9. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 2, Applications, DUNOD, 2001.
10. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 3, Transmission de puissance par liens flexibles, DUNOD, 1999.
11. Bawin, V. et Delforge, C., « Construction mécanique », Edition originale : G. Thome, Liège, 1986.
12. M. Szwarcman, « Eléments de machines », édition Lavoisier, 1983.
13. W. L. Cleghorn, "Mechanics of machines", Oxford University Press, 2008.

Semester: 5
Teaching unit: DTU 3.1
Subject 2: Regulation and control
SVH: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Recognize the main techniques for regulating mechanical systems and the components used.

Recommended prior knowledge:

Mathematics, numerical methods.

Content:

Chapter 1. Control Systems Terminology (1 Week)

Functional diagram of a servo system, Constituent elements of a functional diagram of a servo system.

Chapter 2. Laplace Transformation (2 Weeks)

Definitions and properties.

Chapter 3. Transfer Functions (2 Weeks)

Algebra of functional diagrams and transfer function of systems.

Chapter 4. Study of a first order controlled system (3 Weeks)

Definition and transfer function, System response to different input signals.

Chapter 5. Study of a second order controlled system (3 weeks)

Definition and transfer function, Response of the system to different input signals, Representation of the system in the complex plane.

Chapter 6. BODE and Nyquist diagram of controlled systems (2 Weeks)

Chapter 7. Stability study of servo systems (2 Weeks)

Analytical stability criteria according to Routh and Hurrwitz, Geometric criterion according to Nyquist.

Evaluation method:

Exam: 100%.

References:

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

Semester: 5
Teaching unit: TTU 3.1
Subject: Environment and sustainable development
SHV: 23h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Sensibiliser l'étudiant à la relation entre énergie, environnement et développement durable et maîtriser les sources de pollution ; les réduire afin de garantir un développement durable.

Recommended prior knowledge:

Mécanique des fluides, thermodynamique Fondamentale, transferts thermiques, et caractéristiques de l'environnement.

Content::

Chapter 1. Introduction to the concept of environment (2 Weeks)

Definition of environment, General definition, Legal definition, Brief history, Man and the environment, How man has modified his environment, Scapegoat demography.

Chapter 2. The notion of sustainable development (2 Weeks)

Definition, Brief history, the fundamental principles of sustainable development, the principle ethics, The precautionary principle, The principle of prevention, The objectives of sustainable development,the environmental issues of sustainable development.

Chapter 3. Environment and natural resources (4 Weeks)

Introduction, Resources, Water, Air, Fossil fuels (oil, natural gas, etc.),Other energies (solar, wind, hydraulic, geothermal, biomass, etc.), mineral elements,biodiversity, Soils, Food resources.

Chapter 4. Substances (4 Weeks)

The different types of pollutants, Regulated pollutants, Organic compounds, Metalsheavy, Particles, Chlorofluorocarbons, The effects of different substances onthe environment, Greenhouse effect and climate change, Destruction of the ozone layer,Acidification, eutrophication and photochemistry, Acid rain. Ozone peaks; Effects onmaterials ; Effects on ecosystems: forest, fresh water reserve, Effects on health. The differenttypes of transmitters.

Chapter 5. Preservation of the environment (3 Weeks)

Introduction of new materials, Reservation of oil for noble uses, Improvement ofenergy efficiency, Recycling, Economic, legal and regulatory mechanismspreservation of the environment, The role of public authorities in solving problemsenvironmental, The possible option of private solutions, Environmental policiescurrent, The polluter pays principle, Ecological taxation: ecotaxes.

Evaluation method: Exam: 100%.

References:

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

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

Semester: 6
Teaching unit: FTU 3.2.1
Subject 1: Turbomachines 2
SHV7h30 (Class: 3h00; Tutorial: 1h30)
Credits:6
Coefficient: 3

Teaching objectives:

Apply the laws of fluid mechanics and thermodynamics to energy-producing and mechanical energy-consuming machines using compressible fluids. Know the problems related to this type of machine during their operation.

Recommended prior knowledge:

Thermodynamics and fluid mechanics.

Content:

Chapter 1. Presentation of an axial turbine (1 week)
Concepts of aerodynamics of supporting profiles, lift and drag, loss angle.

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

Chapter 3. General equations of turbomachines (3 weeks)
Conservation of total enthalpy in a fixed channel, conservation of rothalpy in a moving channel.

Chapter 4. Study of nozzles (simple nozzle and Laval nozzle) (3 weeks)
Different operating regimes (subsonic, sonic, supersonic), Sonic blocking, Straight front shock waves.

Chapter 5. Theory of the single-cell turbine (1 week)
Principle and definition, expressions of mass work, speed triangle, role of the fixed channel and moving channel, thermodynamic representation of real operation on the diagram (h,s), losses in the stator, losses in the rotor, losses per remaining speed , concept of available fall, aerodynamic efficiency.

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

Chapter 7. Compressors (3 weeks)
Triangle of speeds, Thermodynamic evolution of the fluid in the case of a compression machine, Calculation of work mass and power, yields, pumping phenomenon in compressors.

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

Evaluation method:

Continuous control: 40%; Exam: 60%.

Reference:

1. P. HENRY, « Turbomachines hydrauliques », Presses Polytechniques et Universitaires Romandes, 1992.
2. M. Sedille, « Turbomachines Hydrauliques et thermiques », Masson 1970.
3. P. Henry, « Turbomachines hydrauliques », 1992.
4. Peng, "Fundamentals of Turbomachinery", Wiley and Sons 2008.
5. M. Pluviose, « Ingénierie des turbomachines**,** Circuits, vibrations, effets instationnaires et des exercices résolus », génie énergétique, Ellipses, 2003.
6. P. Chambadal, « La turbine à gaz », 1997
7. R. Bidard et J. Bonnin, « Energétique et turbomachines »**,** Eyrolles, 1979.
8. L. Vivier, « Turbines à vapeur et à gaz », 1965.
9. M. Pluviose, « Conversion d'énergie par Turbomachines », 2009.
10. J. Krysinski, « Turbomachines, théorie générale », OPU, Alger, 1986.
11. R. Bidard, J. Bonnin, « Energétique et Turbomachines », Eyrolles, Paris, 1979.
12. Jaumotte, « Turbopompes centrifuges », P.U. Bruxelles, 1979.
13. Jaumotte, « Turbomachines : ventilateurs, souflantes et compresseurs centrifuges », P.U. de Bruxelles, 1979.
14. Adam Troskolanski, « Les Turbopompes (Théorie Tracé et Construction) », Eyrolles, 1977.

Semester: 6
Teaching unit: FTU 3.2.1
Subject 2: Internal combustion engines
SHV: 45h00 (class: 1h30; tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Know how different types of internal combustion engines work, both thermodynamically and mechanically.

Recommended prior knowledge:

Thermodynamics and mathematics of L1 and L2.

Content:

Chapter 1. General (2 Weeks)

Principle of operation and classification of heat engines, Fuels for internal combustion engines.

Chapter 2. The thermodynamics of engine cycles (4 Weeks)

The Beau de Rochas cycle, The Diesel cycle, The Sabathé cycle, Real cycles and yields, Energy balance, Fuel supply for gasoline engines, Ignition system for gasoline engines, Combustion.

Chapter 3. Actual cycle of an internal combustion engine (4 Weeks)

Admission, Compression, Combustion, Expansion, Exhaust, The parameters indicated, The effective parameters, Construction of the diagram indicated theoretical.

Chapter 4. Dynamics of reciprocating engines (3 Weeks)

Connecting rod crank system: Kinematic study – Dynamic study. Distribution system: Kinematic study – Dynamic study. Balancing.

Chapter 5 Performance and characteristics of reciprocating motors (2 Weeks)

Performance Parameters, Standards, Characteristics: Full load - partial load - universal.

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Reference:

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

Semester: 6
Teaching unit: FTU 3.2.2
Subject 1: Refrigeration machines and heat pumps
SHV: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Learn the cold production techniques and the main technical elements used in this vast field.

Recommended prior knowledge:

Thermodynamics, turbomachines, regulation, machine elements.

content:

Chapter 1. General **(2 Weeks)**

Cold history, Carnot refrigeration cycle, Carnot cycle performance coefficient.

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

Representation of the basic thermodynamic cycle (on a T-s and P-h diagram), Representation of the practical thermodynamic cycle (on a T-s and P-h diagram), Thermal balance of the thermodynamic cycle, Concept of refrigerants, Performance study (COP, etc.), Industrial cold applications

Chapter3. Components of a vapor compression refrigeration machine (3 Weeks)

Compressors, Evaporators, Condensers, Expansion devices.

Chapter4. Other types of refrigeration machines (3 Weeks)

Operating principle of an absorption refrigeration machine, Air refrigeration cycle.

Chapter5. Thermodynamic Cycle of a Heat Pump (3 Weeks)

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

Evaluation method:

Continuous control: 40%; Exam: 60%.

References:

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

Semester: 6
Teaching unit: FTU 3.2.2
Subject 2: Heat Transfer 2
SHV: 45h00 (Class: 1h30; Tutorial: 1h30)
Credits:4
Coefficient: 2

Teaching objctives:

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

Recommended prior knowledge:

Thermodynamics, heat transfer1 and mathematics of L1 and L2.

Content:

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

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

Chapter 2. Heat transfer by radiation (6 Weeks)

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

Chapter 3. Heat exchangers and boilers: (4 Weeks)

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

Evaluation method:

Continuous control: 40%; Exam: 60%.

References:

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

Semester: 6
Teaching unit: MTU 3.2
Subject: End of cycle project
VHS: 45h00 (PW: 3h00)
Credits: 4
Coefficient: 2

Teaching objectives:

Assimilate knowledge from different subjects in a global and complementary manner. Concretely put into practice the concepts instilled during the training. Encourage a sense of autonomy and a spirit of initiative in students. Teach him to work in a collaborative setting by arousing intellectual curiosity in him.

Recommended prior knowledge:

The entire Bachelor's program.

Content:

The theme of the End of Cycle Project must come from a concerted choice between the tutor teacher and a student (or a group of students: pair or even trinomial). The content of the subject must fit in with the objectives of the training and the real skills of the student (Bachelor level). It is also preferable that this theme takes into account the social and economic environment of the establishment. When the nature of the project requires it, it can be subdivided into several parts.

Noticed :

During the weeks during which the students are immersed in the purpose of their project and its feasibility (bibliographic research, search for software or hardware necessary for carrying out the project, revision and consolidation of teaching having a direct link with the subject, etc.), the head of the subject must take advantage of this face-to-face time to remind students of the essential content of the two subjects "Methodology of writing" and "Methodology of presentation '' addressed during the first two semesters of the common base.

At the end of this study, the student must submit a written report in which he must explain as explicitly as possible:

- La présentation détaillée du thème d'étude en insistant sur son intérêt dans son environnement socio-économique.
- The means implemented: methodological tools, bibliographical references, contacts with professionals, etc.
- Analysis of the results obtained and their comparison with the initial objectives.
- Criticism of the discrepancies observed and possible presentation of other additional details.
- Identification of the difficulties encountered by highlighting the limits of the work carried out and the follow-up to be given to the work carried out.

The student or group of students finally presents their work (in the form of a brief oral presentation or on a poster) in front of their tutor teacher and an examining teacher who can ask questions and thus evaluate the work accomplished on the plan. technical and that of the presentation.

Evaluation method : continuous control : 100%

Semester: 6
Teaching unit: MTU 3.2
Subject 2: Practical refrigeration machines and heat pumps
SHV: 22h30 (PW: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Know the behavior of refrigeration machines on a practical level, their performance and their limits.

Recommended prior knowledge:

Refrigeration machines and heat pumps course

Content:

Plan some experiments in relation to refrigeration machines and heat pumps depending on the availability of resources.

Evaluation method:

Continuous control: 100%.

Semester: 6
Teaching unit: MTU 3.2
Subject 3: PW Internal combustion engines
SHV: 15h00 (PW: 1h00)
Credits: 1
Coefficient: 1

Teaching objectives:

Put into practice the knowledge learned in class to evaluate the performance of internal combustion engines.

Recommended prior knowledge:

Internal combustion engine course.

Content:

Plan some experiments related to internal combustion engines depending on the availability of resources.

Evaluation method:

Continuous control: 100%.

Semester: 6
Teaching unit: MTU 3.2
Subject 4: PW regulation and control
SHV: 22h30 (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Show typical examples of regulation and control on energy systems. For example regulation of temperature or pressure on refrigeration machines, regulation of flow rates on exchangers, levels on boilers, rotation speed on turbomachines, etc.

Recommended prior knowledge:

Regulation course and applied energy subjects.

Content:

Plan some experiments in relation to regulation and control.

Evaluation method:

Continuous control: 100%.

Semester: 6
Teaching unit: DTU 3.2
Subject 1: Renewable energies
SHV: 22h30 (class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

To introduce the student to possible work projections in the field of renewable energies such as domestic hot water production installations or drying installations, electricity production in arid areas and areas not served by the electricity network, the notion of service provided, the use of wind, biomass and geothermal energy, etc.

Recommended prior knowledge:

Thermodynamics heat transfer, turbomachines…

Content of the material:

Chapter 1. Solar astronomy (2 Weeks)

Chapter 2. Algerian solar deposit (2 Weeks)

Chapter 3. Thermal conversion of solar energy (4 Weeks)

Flat solar collectors, Solar concentration: Cylindrical, cylindrical-parabolic-paraboloid, heliostats, Applications of solar thermal conversion, Solar heat storage.

Chapter 4. Photovoltaic conversion (3 Weeks)

Physics of photovoltaic cells, The different types of direct conversion cells, The use of direct conversion panels and the notion of service provided.

Chapter 5. Wind energy (2 Weeks)

Wind power, The different types of wind turbines, The use of wind turbines,

Chapter 6. Geothermal energy (1 Weeks)

Geothermal energy: Deposits in Algeria and use,

Chapter 7.Biomass (1 Weeks)

Biomass: The use of waste.

Evaluation method:

Exam: 100%.

References:

1. B. Equer, J. Percebois, « Énergie solaire photovoltaïque, 1 : Physique et technologie de la conversion photovoltaïque », Ellipses, 1993.

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

Semester: 6
Teaching unit: DTU 3.2
Subject 2: Cryogenics
SHV: 22h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Know the different processes for producing very low temperatures. Natural gas liquefaction techniques and production of liquid air compounds.

Recommended prior knowledge:

Thermodynamics and heat transfer.

Content of the material:

Chapter 1. Thermodynamic reminders (1 Week)

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

Chapter 3. Phase change cycles (Rankine) (2 Weeks)
Study of compression and expansion steam turbine cycles.

Chapter 4. Main industrial methods for obtaining low temperatures (3 weeks)
Chapter 5. Ideal liquefaction cycles and minimal work (3 Weeks)

Chapter 6. Actual liquefaction cycles (2 Weeks)

Chapter 7. Gas separation (2 Weeks)
Descriptive aspects of some processes for obtaining industrial gases.

Evaluation method:

Review: 100%.

References:

1. R.B. Scott, “Cryogenic engineering”, Van Nostrand, Princeton, 1959.
2. R.R. Conte, « Eléments de cryogénie », Masson, Paris ,1970.
3. G.G. Haselden, “Cryogenic fundamentals”, Academic Press, London, 1971.
4. R.A. Barron, “Cryogenic systems”, Oxford University Press, New York, 1985.
5. B.A. Hands, “Cryogenic engineering”, Academic Press, London, 1986.
6. S.W. Van Sciver, “Helium cryogenics”, Plenum Press, New York, 1989.
7. K.D. Timmerhaus and T.M. Flynn, “Cryogenic process engineering”, Plenum Press, New York, 1989.

Semester: 6
Teaching unit: TTU 3.2
Subject: Entrepreneurship and business management
VHS: 23h30 (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

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

Recommended prior knowledge:

No special knowledge, except mastery of the language of instruction.

Targeted skills :

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

Content:

Chapter 1 – Operational preparation for employment: (2 Weeks)

Writing the cover letter and developing the CV, Job interview, etc., Documentary research on professions in the sector, Conducting interviews with professionals in the profession and Simulation of job interviews.

Chapter 2 - Entrepreneurship and entrepreneurial spirit: (2 Weeks)

Getting started, Businesses around you, Entrepreneurial motivation, Knowing how to set goals, Knowing how to take risks

Chapter 3 - The profile of an entrepreneur and the profession of Entrepreneur: (3 Weeks)

The qualities of an entrepreneur, Knowing how to negotiate, Knowing how to listen, The place of SMEs and VSEs in Algeria, The main success factors when creating a VSE/SME

Chapter 4 - Finding a good business idea: (2 Weeks)

Creativity and innovation, Recognizing and evaluating business opportunities

Chapter 5–Lancere and running a business: (3 Weeks)

Choosing an appropriate market, Choosing the location of your business, Legal forms of business, Finding help and financing to start a business, Recruiting staff, Choosing your suppliers

Chapter 6 - Development of the business project: (3 Weeks)

The Business Model and the Business Plan, Carry out your business project with the Business Model Canvas

Evaluation method : Exam : 100%

References :

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

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

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

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

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

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

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

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