



الجمهورية الجزائرية الديمقراطية الشعبية People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

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National Pedagogical Committee for Science and Technology

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## **ACADEMIC MASTER'S DEGREE** **HARMONIZED**

### **National Program**

**Update**  
**2025/2026**

Field	Field	Specialization
<i>Science and Technology</i>	HVAC <i>engineering</i>	HVAC <i>Engineering</i>



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# Academic Master's Degree Harmonization

## National Program

### 2025/2026 Update

Specialization	Branch	Field
HVAC Engineering	HVAC Engineering	Science and Technology

## **I – Master's Program Profile**

## Admission requirements

Field	Harmonized Master's degree	Bachelor's degrees giving access to the Master's program	Ranking according to the compatibility of the bachelor's degree	Coefficient assigned to the bachelor's degree
HVAC engineering	HVAC engineering	HVAC engineering	1	1.00
		Energy	2	0.8
		Mechanical engineering	3	0.7
		Process engineering	4	0.65
		Other degrees in the field of science and technology	5	0.60

## G- Student assessment through continuous assessment and personal work:

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- **G1- Assessment through continuous assessment:**
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- The importance of continuous assessment methods in terms of students' learning outcomes is well established. In this regard, Articles 20, 21, and 22 of Decree 712 of November 3, 2011, define and specify the methods and organization of continuous assessment of students according to their course of study. The calculation of continuous assessment averages (tutorials and practical work) is based on a weighting of all the elements that make up this assessment. These articles specify that this weighting is left to the discretion of the teaching team.
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- A survey conducted by the CPND-ST among all teachers in the various universities showed heterogeneity in the implementation of continuous assessment of students. We are therefore forced to admit that there is a real deficit in the effective management of this teaching activity, which has required us to give serious thought to the matter. This, combined with proposals from several institutions, has led to the recommendations below.
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- Analysis of the various proposals from these institutions has shown that Articles 21 and 22 of Decree 712 of November 3, 2011, are indeed not sufficiently explicit and require further clarification. These articles could be enhanced by taking into account the following points, which represent a summary of the proposals received.
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- **1. Proposals relating to subjects with tutorials:**
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- **1.1. Preparation of exercise series:**
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- The teacher responsible for the subject must organize themselves by proposing a series of exercises for each chapter of the course. This series must be comprehensive, with exercises to test understanding of the course and sample exercises to be solved during the tutorial session.
- These exercises must be prepared by the student before coming to the tutorial. This preparation may be assessed. The method of assessment is left to the discretion of the teacher in charge of the tutorial.
- Exercises not solved in the tutorial may be assigned as individual work to be completed by groups of 3 to 4 students and submitted for assessment (deadline: 1 week).
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- **1.2. Written tests:**
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- At the end of each series of exercises (*i.e.*, at the end of each chapter), there will be a short written test. This test must be organized in collaboration with the subject coordinator to ensure fair assessment for all students (especially when several teachers are involved in the tutorials).

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- **1.3. Student participation in tutorials:**
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- This participation must be assessed. The assessment method is left to the discretion of the teacher in charge of the tutorial.
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- **1.4. Student attendance:**
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- Student attendance is mandatory in tutorials and practicals. In lectures, it is difficult to monitor attendance for bachelor's degree students, where class sizes are very large (lecture theater classes). For master's degree students, where class sizes are smaller, attendance must be mandatory in lectures and tutorials.
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- **2. Methodological units (practical work):**
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- As with tutorials, practical work must be prepared by the student. A test to check this preparation must be organized by the teacher before each practical session (in the form of short comprehension questions, multiple-choice questions, a diagram of the practical session, etc.). A report (per working group) must be submitted at the end of the practical work session. To this end, the teacher must prepare a standard report template to facilitate the students' work so that they can submit it at the end of the practical work session.
- At the end of the semester, the teacher organizes a practical test that summarizes all the experiments carried out by the student.
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- **3. Regarding cross-disciplinary subjects and discoveries that do not have tutorials or practical sessions:**
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- It is very difficult to carry out continuous assessment in these subjects due to the absence of tutorials and the very large number of students in most cases, particularly in universities with very high student numbers.
- Nevertheless, the teacher responsible for this subject may, if they wish, inform students that they may be assessed (continuously) by asking them to prepare presentations, write reports, research additional material related to the course, use free software, asking students to watch a popular science film related to the subject at home (after providing them with either the film on electronic media or the internet link to the film) and then asking them to submit a written report or give an oral presentation summarizing the film, etc. The weighting of these activities is left to the discretion of the teacher and the teaching team, who are the only ones able to determine the best way to take this personal work into account in the overall final exam grade.
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- Similarly, if the number of students in this subject is reasonable (20 to 30 students), which may be the case for many master's programs, the subject coordinator may consider continuous assessment of students, as is done in subjects with tutorials. The only requirement is that students must be informed of this procedure and that it must be approved during the first teaching council meeting.
- In any case, the teacher and the teaching team are free to include any type of assessment they deem appropriate to encourage students to take greater responsibility for their studies and, at the same time, combat student absenteeism.
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- **4. Harmonization of continuous assessment:**

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- The use of a common assessment grid would promote the harmonization of these practices from one teacher to another, from one department to another, and from one institution to another. It would also provide a structured and reassuring reference point for students. To this end, we propose below an indicative assessment grid that presents the various forms of continuous assessment used to evaluate the degree to which students have acquired skills in terms of knowledge, analytical abilities, and synthesis skills.
- It should be noted that these assessments are not intended to "trick" students by imposing very difficult continuous assessments. On the contrary, the aim is to "honestly" assess the degree to which students have assimilated the various skills and knowledge taught to them in a completely objective manner. In the same vein, it would be beneficial to promote the contractualization of learning assessment by specifying, for example, the criteria for success and best practices that would lead to correct and accurate answers to questions. In this way, assessment would focus primarily on the skills acquired during training by setting exercises related to what has been prepared in tutorials, without forgetting to assess students' ability to apply their skills in more complex situations.

#### **4-1 Tutorials:**

Preparation of exercise series and personal work (assignments, presentations, etc.)	30%	06 points
Written tests (minimum of two tests, including one set by the course coordinator)	50%	10 points
Student participation in tutorials	20	4
<b>Total</b>	<b>100</b>	<b>20 points</b>

#### **4.2 Practical work:**

Practical work preparation tests	20	04 points
Report (must be submitted at the end of the practical work session)	40	08 points
Practical work test at the end of the semester covering all the procedures carried out by the student.	40	08 points
<b>Total</b>	<b>100</b>	<b>20 points</b>

#### **G2- Student's personal work:**

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- Personal work by students is part of the spirit of the LMD (Bachelor's-Master's-Doctorate) system. A significant amount of weekly time has been set aside for this: approximately 50% of the total number of hours in the program (see the "Overall summary of the program" table in this program description).
- A survey conducted by the CPND-ST among training teams across all universities revealed that the time allocated to student's personal work could be put to good use, under the supervision of the teacher, in a rational manner and in various forms. The tasks completed by volunteer students would then be assessed and counted (as a bonus)

in their overall continuous assessment score. The rate of this bonus is left to the discretion of the teaching teams.

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- The various proposals can be summarized as follows:
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### **1. Homework:**

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- In order to enrich students' knowledge and strengthen their training, they will be asked to complete additional homework guided by their course or tutorial teachers. This type of work will involve, for example, encouraging students to conduct research to answer specific and/or controversial questions raised during the course, solve a difficult exercise, review the proof of a theorem in detail, research additional material related to a course, use free software or CAD/CAM tools to create applications and simulations related to the course, etc. These activities can be assessed, graded, and recorded as bonus points for the students who complete them.
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### **2. Mini course project:**

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- The mini course project (1 to 3 weeks) is an effective way to prepare students for the methodology of expression, writing, and documentary research. It is a means of putting into practice the techniques learned in cross-disciplinary subjects. It also allows students to develop teamwork skills.
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- 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), assessed by a single report (10 pages maximum) and a short collective oral presentation (preferably with audio-visual support). A single grade for the group is awarded according to an assessment grid (presentation of the document and use of bibliographic resources, oral presentation, adherence to time limits, answers to questions, etc.) and will then be added as a bonus to the continuous assessment grade.
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### **3. Report on a visit, educational outing, or discovery and/or immersion internship:**

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- Visits, educational outings, discovery and/or immersion internships are opportunities for students to better understand the reality of the working world and ultimately help them to integrate into the workforce more successfully.
- Administrative staff and teachers should encourage this very important aspect of the program as much as possible and ensure that visits and educational outings are organized throughout the program.
- They must also help/encourage students to explore economic institutions with the aim of finding (in L3 and M1) discovery, and/or immersion internships lasting one to two weeks in an industrial setting during the winter and spring breaks.
- In this context, teachers must ensure that students take notes during these outings and require reports (a few pages long). This activity can be evaluated, graded, and recorded as a bonus for the student who completes it. Students can be provided with templates to help them present their internship reports effectively.
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### **4. Participation in scientific events:**

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- In order to instill a scientific mindset in students (especially those at the higher level), they should be guided and encouraged to participate in round tables, laboratory seminars, and conferences organized within their faculty and/or institution. It is even advisable to encourage these students to attend conferences related to their field of study outside their university at exhibitions, fairs, and other events. This activity can be evaluated, graded, and recorded as a bonus for the student who participates.

- **5. Use of New Information and Communication Technologies:**

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

- **Conclusion:**

- Student autonomy, considered a lever for success, relies largely on the personal work that students are required to do, by appropriating the resources and tools made available to them. All of this must, of course, be supervised and formalized as part of the educational monitoring and support provided jointly by the university teacher and the administrative manager throughout the student's course of study.
- This autonomy will enable students to build their professional identity in line with their aspirations, abilities, and achievements, or to build their academic career in pursuit of higher education.

## **II – Semester-based course organization sheets for the specialization**



**Semester 1: Master's in Climate Engineering**

Teaching unit	Subjects	Credits	Coefficient	Weekly hours			Semester hours (15 weeks)	Additional work in Consultation (15 weeks)	Assessment method	
	Title			Course	Tutorial	Practical			Continuous assessment	Exam
Fundamental EU Code: UEF 1.1.1 Credits: 10 Weighting: 5	Heating of Residential Buildings	4	2	1.5	1.5		45	55 hours	40	60
	Ventilation and Air Conditioning I	4	2	1.5	1 hour 30 minutes		45	55 hours	40	60
	Applied electrical engineering	2	1	1.5			10:30 p.m.	27:30		100%
Fundamental EU Code: UEF 1.1.2 Credits: 8 Coefficients: 4	Hydraulic Networks	4	2	1.5	1 hour 30 minutes		45	55 hours	40	60
	Industrial refrigeration technology	4	2	1.5	1 hour 30 minutes		45	55 hours	40	60
Methodological EU Code: UEM 1.1 Credits: 9 Coefficients: 5	Numerical Calculation & Modeling	4	2	1.5 hours		1.5	45	55 hours	40	60
	Advanced programming in Python	2	2	1.5 hours		1.5	45	55 hours	40	60%
	Electrical Engineering Practical	2	1			1.5	10:30 p.m.	27:30	100	

	Practical work: Refrigeration machines	2	1			1:30	10:30 p.m.	27:30	100	
	DAO HVAC networks	1	1			1:00	3:00 p.m.	10:00	100%	
Discovery Unit Code: UED 1.1 Credits: 1 Coefficients: 1	Renewable energies	1	1	1.5			10:30 p.m.	2:30 a.m.		100%
<b>Total semester 1</b>		<b>30</b>	<b>17</b>	<b>12:00</b>	<b>6:00</b>	<b>7:30</b>	<b>382 hours 30 minutes</b>			

### Semester 2: Master's in Climate Engineering

Teaching unit	Subjects	Credits	Coefficient	Weekly hours			Semester hours (15 weeks)	Additional work in Consultation (15 weeks)	Assessment method	
	Title			Course	Tutorial	Practical			Continuous assessment	Exam
Fundamental EU Code: UEF 1.2.1 Credits: 8 Coefficients: 4	Cooling and Drying Production	4	2	1 hour 30 minutes	1 hour 30 minutes		45 hours	55 hours	40	60
	Ventilation and Air Conditioning II	4	2	1.5	1.5		45	55 hours	40	60%
Fundamental EU Code: UEF 1.2.2 Credits: 10	HVAC Systems Regulation	4	2	1.5 hours	1 hour 30		45	55 hours	40	60

Coefficients: 5					minutes					
	Heating Systems	6	3	1.5	1 hour 30 minutes	1 hour 30 minutes	67 hours 30 minutes	82 hours 30 minutes	40	60
Methodological EU Code: UEM 1.2 Credits: 9 Coefficients: 5	Use of software applied to refrigeration and air conditioning	4	2	1.5		1.5	45	55 hours	40	60
	Air conditioning systems	4	2	1.5		1 hour 30 minutes	45	55 hours	40	60
	Practical work: HVAC system regulation	1	1			1.5	10:30 p.m.	10:00	100%	
Cross-disciplinary Code: UET 1.2 Credits: 3 Coefficients: 3	Compliance with standards and rules of ethics and integrity	1	1	1.5			10:30 p.m.	2:30		100%
	Elements of applied artificial intelligence	2	2	1 hour 30 minutes		1 hour 30 minutes	45 hours	5:00	40%	60%
<b>Total semester 2</b>		<b>30</b>	<b>17</b>	<b>12:00</b>	<b>6:00</b>	<b>7:30</b>	<b>382 hours 30 minutes</b>			

**Semester 3: Master's in Climate Engineering**

Teaching unit	Subjects	Credits	Coefficient	Weekly hours			Semester hours (15 weeks)	Additional work in Consultation (15 weeks)	Assessment method	
	Title			Course	Tutorial	Practical			Continuous assessment	Exam
Fundamental EU Code: UEF 2.1.1 Credits: 10 Coefficients: 5	Heat Exchangers	4	2	1.5	1 hour 30 minutes		45	55 hours	40	60
	Industrial Ventilation and Environmental Protection	4	2	1.5	1 hour 30 minutes		45	55 hours	40	60%
	Air conditioning and industrial refrigeration design office	2	1	1.5			10:30 p.m.	27:30		100%
Fundamental EU Code: UEF 2.1.2 Credits: 8 Coefficients: 4	Control and Automation of Energy Installations	4	2	1.5	1.5		45	55 hours	40	60
	Cryogenic processes	4	2	1.5	1 hour 30 minutes		45	55 hours	40	60
Methodological EU Code: UEM 2.1	Refrigeration Systems	4	2	1.5		1 hour 30	45	55 hours	40	60

Credits: 9 Coefficients: 5						minutes				
	Operational research	3	2	1.5 hours		1 hour 30 minutes	10:30 p.m.	27:30	40%	60
	Practical work: Repairing refrigeration and air conditioning systems	2	1			1.5	10:30 p.m.	27:30	100%	
Cross-disciplinary EU Code: UET 2.1 Credits: 3 Coefficients: 3	Documentary research and thesis design	1	1	1:30 a.m.			10:30 p.m.	2:30 a.m.		100%
	Reserve engineering	2	2	1 hour 30 minutes		1.5 Workshop	45 hours	55 hours	40%	60%
<b>Total semester 3</b>		<b>30</b>	<b>17</b>	<b>1:30 p.m.</b>	<b>6:00</b>	<b>6:00</b>	<b>382.5 hours</b>			

**Semester 4**

This semester is devoted to completing the master's degree final project. It is carried out in a company or research laboratory (university or research center). It is assessed by a thesis and a defense.

	VHS	Coefficient	Credits
Personal work	55	09	18
Internship in a company or laboratory	100	04	06
Seminars	50	02	03
Other (Supervision)	50	02	03
Total Semester4	750	17	30

**This table is provided for informational purposes only.**

**Evaluation of the Master's Degree Final Project**

- Scientific value (Assessment by the jury) /6
- Thesis writing (Assessment by the jury) /4
- Presentation and response to questions (Assessment by the jury) /4
- Supervisor's assessment /3
- Presentation of the internship report (Assessment by the jury) /3

**III - Detailed program by subject S1**

**Semester: 1**

**Teaching unit: UEF 1.1.1**

**Subject 1: Heating of Residential Buildings**

**VHS: 45 hours (Lectures: 1.5 hours, Tutorials: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Teaching objectives**

The objective of this fundamental unit is to teach students the methodology to follow to calculate total and basic heat loss for a dwelling or commercial building and to deduce the heating power to be installed (according to the updated regulatory technical document). The different heating systems used in domestic and commercial buildings (individual and centralized hot water) will also be discussed. The contribution of thermal insulation to reducing heat loss and optimizing energy consumption will also be discussed.

### **Recommended prior knowledge**

Knowledge of the main principles of heat transfer, fluid mechanics, and thermodynamics.

### **Course content**

- |  |                  |
|--|------------------|
| 1. INDOOR AND OUTDOOR CLIMATE CONDITIONS | <b>(2 weeks)</b> |
| 2. CALCULATING HEATING REQUIRE           | <b>(4 weeks)</b> |
| 3. THERMAL PROTECTION OF THE BUILDING    | <b>(2 weeks)</b> |
| 4. HEATING ELEMENTS                      | <b>(2 weeks)</b> |
| 5. INDIVIDUAL HEATING                    | <b>(2 weeks)</b> |
| 6. HOT WATER CENTRAL HEATING SYSTEM      | <b>(3 weeks)</b> |

### **Assessment method**

Continuous assessment: 40%; Exam: 60%.

### **Bibliographic references**

1. Technical Regulatory Document, DTR C3-2/4, Thermal regulations for buildings, National Center for Integrated Building Studies and Research, 2017.
2. A.R. Day, M.S. Ratcliffe and K.J. Shepherd, Heating Systems, Plant and Control, Blackwell Science, 2003.
3. M. Jedidi and O. Benjeddou, Building Thermodynamics, from Thermal Comfort to the Choice of Heating and Air Conditioning Equipment, Dunod 2016.
4. D. P. Muniak, Radiators in Hydronic Heating Installations. Structure, Selection and Thermal Characteristics, Springer International Publishing AG 2017.
5. John Siegenthaler, P.E., Modern Hydronic Heating for Residential and Light Commercial Buildings, Delmar Cengage Learning, 3<sup>rd</sup> edition, 2012.
6. Georges DEUTSCH. *Central Heating*. Chihab-Eyrolles edition, 1996, 219p.
7. Jean-Marc GUILLOU. *Plumbing*. Chihab-Eyrolles Edition, 1996, 135 p.
8. Christian PESSEY. Heating and Air Conditioning. La Maison Rustique Publishing,
9. Flammarion. 2000. 128 p.
10. P. CHARDOT and P. PARROT. Practical Guide to the Costic Gas Burner, SEDIT2005

**Semester: 1**

**Teaching unit: UEF 1.1.1**

**Subject 2: Ventilation and Air Conditioning I**

**VHS: 45 hours (Lectures: 1.5 hours, Tutorials: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Teaching objectives**

To enable students to apply the principles of heat exchange and fluid mechanics to calculate the thermal and mass balances of a room, as well as air conditioning distribution networks.

### **Recommended prior knowledge**

Students must have a good foundation in heat transfer, fluid mechanics, and thermodynamics.

### **Course content**

- |   |                  |
|---|------------------|
| 1. INTRODUCTION                                     | <b>(1 week)</b>  |
| 2. CLIMATE PARAMETERS FOR CALCULATION               | <b>(2 weeks)</b> |
| 3. THERMAL COMFORT AND INDOOR PARAMETERS            | <b>(2 weeks)</b> |
| 4. THERMAL BALANCE OF THE ROOM ACCORDING TO THE DTR | <b>(2 weeks)</b> |
| 5. MASS BALANCE OF THE PART ACCORDING TO THE DTR    | <b>(2 weeks)</b> |
| 6. CALCULATION OF AIR FLOWS FOR I.V.C.A.            | <b>(2 weeks)</b> |
| 7. AIR DISTRIBUTION IN THE PREMISES                 | <b>(2 weeks)</b> |
| 8. AIR DISTRIBUTION IN FACILITIES                   | <b>(2 weeks)</b> |

### **Assessment method**

Continuous assessment: 40%; Exam: 60%.

### **Bibliographical references**

1. H. RIETSCHHELL and W. RAISS. Treatise on Heating and Air Conditioning, Volumes I and II. Dunod Edition, 1974, 676 p.
2. G. PORCHER. Air Conditioning Course: Calculation Basics for Air Conditioning Systems. 7th edition, Les éditions parisiennes CFP, 1993.
3. Christian PESSEY. Heating and Air Conditioning. La Maison Rustique Publishing,
4. Flammarion. 2000. 128 p.
5. R. CADIERGUES. Handbook of Climate Engineering, SEDIT, 2006
6. T. SALOMON and C. AUBERT. Cool without air conditioning, Terre vivante, 2004
7. M. BOSSARD. Air Conditioning in the Home, Foucher, 2002
8. Ph. COURTIN. Air Conditioning, Air Conditioning - Volume 5 - Calculating Discharges, Les éditions parisiennes (EDIPA), 2002

**Semester: 1**  
**Teaching unit: UEF.1.1.1**  
**Subject 3: Applied Electrical Engineering**  
**VHS: 22.5 hours (Lectures: 1.5 hours)**  
**Credits: 2**  
**Coefficient: 1**

### **Teaching objectives**

To provide the knowledge and skills necessary to acquire basic expertise in the field of electrical engineering: component sizing, installation, adjustment, and operation.

### **Recommended prior knowledge**

General electricity, electromagnetism, electrical installations.

### **Course content**

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|---|------------------|
| 1. General  | <b>(1 week)</b>  |
| 2. Equipment (circuit breakers, switches, contactors, fuses, etc.)              | <b>(2 weeks)</b> |
| 3. <b>Single-phase</b> transformers   | <b>(2 weeks)</b> |
| 4. Three-phase sources, three-phase transformers                                | <b>(2 weeks)</b> |
| 5. Direct current machines  | <b>(2 weeks)</b> |
| 6. Synchronous rotating machines  | <b>(2 weeks)</b> |
| 7. Asynchronous rotating machines   | <b>(2 weeks)</b> |
| 8. Electrical layout (distribution boards, control stations<br>, signal panels) | <b>(2 weeks)</b> |

### **Assessment method**

Exam 100%

### **Bibliographic references**

Book: "Electrical Engineering: Transformers, Electric Motors," Author: Robert MERAT,  
 Publisher: Nathane (1997), EAN-13: 9782091779928, ISBN-10: 2091779927.

**Semester: 1**

**Teaching unit: UEF 1.1.2**

**Subject 1: Hydraulic Networks**

**VHS: 45 hours (Lectures: 1.5 hours; Tutorials: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Course objectives**

Students will learn about the principles of hot and cold water distribution in buildings, as well as dimensioning methods. The course will also cover primary and secondary networks, distribution equipment, balancing, and regulation. Ancillary equipment for such installations will also be covered (expansion tanks, water softeners, expansion compensators, filters, air vents).

### **Recommended prior knowledge**

Students must have a solid foundation in heat transfer and fluid mechanics.

### **Course content**

- |   |                  |
|---|------------------|
| 1. Introduction   | <b>(1 week)</b>  |
| 2. Hydraulic networks   | <b>(4 weeks)</b> |
| 3. Hydraulic pumps  | <b>(2 weeks)</b> |
| 4. Combination of pumps and networks  | <b>(4 weeks)</b> |
| 5. Water expansion  | <b>(2 weeks)</b> |
| 6. Ancillary equipment (water softeners, expansion compensators, air vents, etc.) | <b>(2 weeks)</b> |

### **Assessment**

Continuous assessment: 40%; Exam: 60%.

### **Bibliographical references**

1. Le Recknagel, Practical Handbook of Climate Engineering, Volume 2: Heating and Domestic Hot Water Production, PYC Éditions Livres, 3rd edition, 1996.
2. Bouteloup J., Le Guay M., Ligen J., Air Conditioning and Air Conditioning, Volume 3.2: Hydraulic and Aerodynamic Fluid Distribution, EDIPA Éditions Parisiennes, 2002.
3. Bouteloup J., Le Guay M., Ligen J., Fluid Mechanics, Volume 3.1, EDIPA Éditions Parisiennes, 2002.
4. S. K. Wang, Handbook of Air Conditioning and Refrigeration,<sup>2nd</sup> edition, McGraw Hill, New York, 2001.

**Semester: 1**

**Teaching unit: UEF 1.1.2**

**Subject 2: Industrial Refrigeration Technology**

**VHS: 45 hours (practical work: 1 hour 30 minutes; 1 hour 30 minutes)**

**Credits: 4**

**Coefficient: 2**

### **Teaching objectives**

To provide advanced training in the operation and use of industrial refrigeration machines and to present the various components involved in these machines.

### **Recommended prior knowledge**

Refrigeration systems

### **Course content**

- |  |                  |
|--|------------------|
| 1. General information on refrigeration machines   | <b>(1 week)</b>  |
| 2. Compressors                                     | <b>(2 weeks)</b> |
| 3. Heat exchangers                                 | <b>(2 weeks)</b> |
| 4. Condensers                                      | <b>(1 week)</b>  |
| 5. Pressure capacities                             | <b>(1 week)</b>  |
| 6. Pressure regulators and pressure relief systems | <b>(1 week)</b>  |
| <br>   |                  |
| 7. Refrigeration piping and accessories            | <b>(2 weeks)</b> |
| 8. Water and refrigerant pumps                     | <b>(2 weeks)</b> |
| 9. Atmospheric coolers                             | <b>(2 weeks)</b> |
| 10. Control equipment                              | <b>(1 week)</b>  |

### **Assessment method**

Continuous assessment 40% and exam 60%

### **Bibliographic references**

Book: "Froid industriel" (Industrial Refrigeration), 2nd edition, Author: Francis MEUNIER, Publisher: Dunod/Revue pratique du froid (2005), ISBN-10: 210048527X, ISBN-13: 9782100053018.

**Semester: 1**

**Teaching unit: UEM 1.1**

**Subject 1: Numerical Calculation and Modeling**

**VHS: 45 hours (Lectures: 1.5 hours; Practical work: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Course objectives**

To provide tools, numerical methods, and algorithms for solving traditional physics equations. It also consolidates the computer skills acquired in the Algorithms & Programming course.

### **Recommended prior knowledge**

Algorithms, programming.

### **Course content**

- |  |                  |
|--|------------------|
| 1. General   | <b>(1 week)</b>  |
| 2. Interpolation problems  | <b>(1 week)</b>  |
| 3. Numerical differentiation   | <b>(1 week)</b>  |
| 4. Numerical integration   | <b>(1 week)</b>  |
| 5. Linear system solving   | <b>(1 week)</b>  |
| 6. LU and Cholesky decomposition                                       | <b>(2 weeks)</b> |
| 7. Solving linear systems using iterative methods                      | <b>(2 weeks)</b> |
| 8. Numerical methods for calculating eigenvalues of a symmetric matrix | <b>(2 weeks)</b> |
| 9. Nonlinear equations and systems of equations                        | <b>(2 weeks)</b> |
| 10. Differential equations   | <b>(2 weeks)</b> |

### **Assessment**

Continuous assessment 40% and exam 60%

### **Bibliographic references**

Book: Introduction à l'analyse numérique (Introduction to Numerical Analysis), 2nd edition, Author: Jacques RAPPAZ, Publisher: Presses Polytechniques et Universitaires Romandes (2010), EAN13: 9782880748517.

**Semester: S1**

**Teaching unit: UET 1.1.1**

**Subject: Advanced Programming in Python**

**VHS: 45 hours (1.5 hours of lectures, 1.5 hours of practical work)**

**Credits: 2**

**Coefficient: 2**

**Course objectives:**

**Targeted skills:**

- Use of IT tools for the acquisition, processing, production, and dissemination of information
- Python and project management skills
- Skills in automation and data visualization.

**Objectives:**

- To deepen students' mastery of the Python language and introduce them to the basics of data analysis and artificial intelligence.
- Acquire a solid foundation in computer science.
- Learn to program in Python and Excel
- Master task automation
- Master project management software

**Required equipment:**

- A computer with Python installed.
- Python libraries: NumPy, Pandas, Scikit-learn, Matplotlib, os.listdir, os.path.exists, os.mkdir, os.rmdir, Matplotlib, Seaborn, Plitly, Request, Beautiful Soup, Tkinter, PyQt, etc.
- Tensorflow, PyTorch, etc.

**Prerequisites:** Python programming,

**Course content:**

**Chapter 1: Review of Python programming (2 weeks)**

1. Introduction: Basic concepts in computer science and digital tools, Python installation.
2. Presentation of the concept of operating systems: roles, types (Linux, Windows, etc.), priority management,
3. Introduction to computer networks (principles, IP addresses, DNS, internet, etc.)
4. Basic programming: Interactive mode and script mode, variables, data types, operators. Conditional structures and loops (if, for, while).
5. Functions and essential elements: Predefined functions and function creation. Standard modules (math, random). Character strings, lists, basic data manipulation.
6. Files, lists, tuples, dictionaries,
7. Exercises:
  - Python learning exercises
  - Exercises using libraries covered in class (Math, Random, NumPy, Pandas, etc.)
  - ...

**Chapter 2: Programming and automation**

**(4 weeks)**

1. Principles of task automation
  - Python libraries for automation:
    - ✓ Pandas and NumPy.

- ✓ Os, shutil: file and folder manipulation
- ✓ Openpyxl or pandas: working with Excel or CSV files
- Definitions and examples of automation (sending emails, etc.)

## 2. File manipulation with Python:

- Using libraries to:
  - ✓ Browsing a folder (os.listdir)
  - ✓ Checking whether a file or folder exists (os.path.exists)
  - ✓ Creating or deleting folders (os.mkdir, os.rmdir)
  - ✓ Visualizing data: Matplotlib, Seaborn, Plitly
  - ✓ Request to interact with Application Programming Interfaces (APIs)
  - ✓ BeautifulSoup for data scraping
  - ✓ Tkinter, PyQt for viewing graphical data
- Copy or move files with shutil...
- Searching, sorting, and generating simple reports.
- Serialization and deserialization (using the pickle module).
- Serialization of objects and processing of large files (streaming).
- ...

## 3. Exercises:

- Using openpyxl and pandas to read, modify, and write Excel or CSV files to:
  - ✓ Creating automatic reports
  - ✓ Automatically extract data
  - ✓ ...
- Writing scripts to:
  - ✓ Processing text files (searching, sorting)
  - ✓ automating technical calculations
  - ✓ managing simple reports (PDF, Excel)
  - ✓ ...
- Sorting, search, and insertion sort algorithms
- Implement a search function in a list.
- File operations
- Secure browsing (simple network configuration, password management)
- ....

## Chapter 3: Advanced Excel learning

(2 weeks)

1. Macro principles and creating a simple macro
2. Pivot tables,
3. Histograms,
4. Bar charts,
5. Spider charts,
6. etc.
7. Excel exercises ....

## Chapter 4: Learning GanttProject

(2 weeks)

1. Introduction to project management:
  - What is a project?

- What are the challenges of managing a project?
  - GanttProject interface
2. Tasks (creation, modification, organization)
  3. Time management (project start and end dates)
  4. Resource management
  5. Exercises on Gantt Project

## Chapter 4: Advanced object-oriented programming (3 weeks)

1. Code organization:
  - Custom functions, parameters, return values.
  - Modules, imports, and packages.
2. Complex data structures:
  - Lists, tuples, and dictionaries: creation, modification, deletion, traversal.
3. Fundamental concepts of object-oriented programming (OOP):
  - Classes, objects, attributes, and methods.
  - Public, private, and protected attributes.
4. Special methods:
  - **init**, **str**, **repr**, **len**.
5. Advanced concepts:
  - Encapsulation, abstraction, inheritance, polymorphism.
  - Advanced inheritance, decorators, design patterns, metaclasses.
6. Exercises

## Chapter 5: Introduction to data for AI (2 weeks)

1. Introduction to common datasets in AI:
  - Iris, MNIST, CIFAR-10, Boston Housing, ImageNet.
2. Data preprocessing for machine learning:
  - Cleaning, normalization, encoding, data separation.
  - Cross-validation.
3. Feature engineering techniques:
  - Selection, feature creation, dimension reduction.
4. Essential libraries for AI model development:
  - scikit-learn, TensorFlow, Keras, PyTorch
5. Exercises

### Practical work:

#### TP 01: Mastering the basics of Python programming

*(Control structures, types, loops, simple functions)*

1. Introduction
2. Reading and processing text files
3. Managing simple reports (PDF, Excel)

#### TP 02:

- Develop specifications for a mini task automation project using Python, consisting of automatically identifying and sending reports by email using Python:

1. Load data from a file (e.g., experimental measurements),
2. Perform simple statistics on the data (mean, standard deviation with interpretation),
3. Generate a graph,
4. Send the result using Python.

#### TP 03:

1. Programming the dashboard seen in the tutorial using Excel
2. Creating automated Excel tables
3. Simple macros,
4. Conditional formulas,
5. V lookup.

#### Practical assignment 04:

Organize a meeting in Ganttproject

1. Create a new project:
  - Project name: "Meeting ..."
  - Start date: Date and time of the meeting
  - Estimated duration: total duration of the meeting
2. Definition of tasks
  - Agenda items (each agenda item becomes a task)
  - Subtasks: If an item is complex, create the corresponding subtasks
  - Initial and final tasks (e.g., "Welcome participants," "Close the meeting")
3. Definition of resources:
  - Participants (each participant is a resource)
  - Equipment (computer, data projector, etc.)
4. Estimated duration:
  - Duration of each item: time required for each item on the agenda
  - Transition time from one item to another
5. Creating the Gantt chart:
  - Viewing the agenda
  - Identify key items
6. Monitor progress in real time (Gantt chart projection)

#### TP 05: Advanced structures and code organization

*(Custom functions, dictionaries, modules, and modular organization)*

#### TP 06: Advanced object-oriented programming in Python

*(Encapsulation, inheritance, special methods, simple design patterns)*

#### TP 07: File manipulation and data analysis

*(Reading/writing files, text processing, introduction to Pandas and NumPy)*

#### TP 08: Data preparation and processing for artificial intelligence

*(Loading AI datasets, cleaning, transformation, feature selection)*

#### Final project

**Title:** Analysis and visualization of a dataset + simple predictive model

**Skills used:** Data reading, OOP, advanced structures, Pandas, Scikit-learn. (Oral presentation + written report).

**Assessment method:**

**exam 60%, CC=40%**

**Bibliography**

- [1] .E.Schultz and M.Bussonnier (2020): Python for the Humanities and Social Sciences. Introduction to data programming. Presses Universitaires de Rennes.
- [2] .C. Paroissin, (2021): Data science in practice with R: organizing, visualizing, analyzing, and presenting data. Paris: Ellipses, DL 2021.
- [3] .S. Balech and C. Benavent: NLP texte minig V4.0, (Paris Dauphine – 12/2019): link: [https://www.researchgate.net/publication/337744581\\_NLP\\_text\\_mining\\_V40\\_-\\_une\\_introduction\\_-\\_cours\\_programme\\_doctoral](https://www.researchgate.net/publication/337744581_NLP_text_mining_V40_-_une_introduction_-_cours_programme_doctoral)
- [4] .Allen B. Downey Think Python: How to Think Like a Computer Scientist, O'Reilly Media, 2015;
- [5] .Ramalho, L.. Fluent Python. " O'Reilly Media, Inc.", 2022;
- [6] .Swinnen, G.. Learn to program with Python 3. Editions Eyrolles, 2012;
- [7] .Matthes, E. Python crash course: A hands-on, project-based introduction to programming. no starch press, 2019
- [8] .Cyrille, H. (2018). Learning to Program with Python 3. Eyrolles, 6th edition. ISBN: 978-2212675214
- [9] .Daniel, I. (2024). Learning to code in Python, J'ai lu
- [10] . Nicolas, B. (2024). Python, from complete beginner to object-oriented programming: Lessons and corrected exercises, 3rd edition, Ellipses
- [11] . Ludivine, C. (2024). Selenium Master your functional tests with Python, Eni

**Online resources:**

- Official Python documentation: [docs.python.org](https://docs.python.org)
- Python exercises on Codecademy: [codecademy.com/learn/learn-python-3](https://codecademy.com/learn/learn-python-3)
- W3Schools Python Tutorial: [w3schools.com/python/](https://w3schools.com/python/)

**Semester: 1**

**Teaching unit: UEM 1.1**

**Subject 2: Electrical Engineering Practical**

**VHS: 22:30 (practical work: 1:30)**

**Credits: 2**

**Coefficient: 1**

**Course objectives**

To provide the knowledge and skills necessary to acquire basic expertise in the field of electrical engineering: component sizing, installation, adjustment, and operation.

**Recommended prior knowledge**

General electricity, electromagnetism.

**Course content**

<b>TP1: Electrical Machines</b>	<b>(3 weeks)</b>
-Direct current machines	
-Synchronous rotating machines	
-Asynchronous rotating machines	
<b>TP2: Electrical Layout</b>	<b>(3 weeks)</b>
-Distribution boards	
-Control stations	
-Signaling panels	
<b>TP3: Equipment</b>	<b>(3 weeks)</b>
-Circuit breakers	
-Switches	
-Contactors, fuses	
<b>TP4: Three-phase sources</b>	<b>(3 weeks)</b>
<b>TP5: Single-phase and three-phase transformers</b>	<b>(3 weeks)</b>

**Assessment method**

Exam 100%.

**Semester: 1**

**Teaching unit: UEM 1.1**

**Subject 3: Practical work on refrigeration machines**

**VHS: 22.5 hours (practical work: 1.5 hours)**

**Credits: 2**

**Coefficient: 1**

### **Teaching objectives**

This subject will enable students to calculate the total heat input in order to size the various components of the test bench. To achieve the objectives set, students must present the scientific approach used to assemble this test bench by determining the cycles and performance of a refrigeration machine.

### **Recommended prior knowledge**

Thermodynamics, refrigeration machines.

### **Course content**

1. Visualization of the cycle of a vapor compression refrigeration machine **(5 weeks)**
2. Study of the cycle and performance of a refrigeration machine **(5 weeks)**
3. Recovery and charging of refrigerant in a refrigeration circuit **(5 weeks)**

### **Assessment method**

Exam: 100%.

**Semester: 1**

**Teaching unit: UEM 1.1**

**Subject 4: CAD for HVAC networks**

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

**Credits: 1**

**Coefficient: 1**

### **Course objectives**

Learn how to use computer-aided design software and methods. Use the knowledge acquired to dimension a mechanical system.

### **Recommended prior knowledge**

Mechanical engineering, technical drawing, computer-aided design. Digital modeling tools.

### **Course content**

1-2D creation tools: lines, arcs, hatching	<b>(2 weeks)</b>
2-Using 3D creation tools: library objects	<b>(2 weeks)</b>
3-Moving, copying, and rotating along various axes	<b>(1 week)</b>
4-Creating library objects	<b>(1 week)</b>
5-Diagrams and standards in HVAC engineering	<b>(1 week)</b>
6-2D and 3D network design	<b>(2 weeks)</b>
7-Creating the basic document => developing the 3D model	<b>(2 weeks)</b>
8-Convert the basic 3D document => develop 2D views	<b>(2 weeks)</b>
9- Produce the final presentation => import and format the 2D views	<b>(2 weeks)</b>

### **Assessment method**

Exam 100%

### **Bibliographic references**

Solidworks Software Tutorial.

**Semester: 1**  
**Teaching unit: UED 1.1**  
**Subject: Renewable energies**  
**VHS: 22.5 hours (Classes: 1.5 hours)**  
**Credits: 1**  
**Coefficient: 1**

**Teaching objectives:**

Introduce students to potential career paths in the field of renewable energies, such as domestic hot water production or drying facilities, electricity production in arid areas and areas not served by the electricity grid, the concept of service provision, the use of wind, biomass, and geothermal energy, etc.

**Recommended prior knowledge:**

Thermodynamics, heat transfer, turbomachinery, etc.

**Course content:**

**Chapter 1. Solar astronomy** (2 weeks)

**Chapter 2. Algerian solar resources** (2 weeks)

**Chapter 3. Thermal conversion of solar energy** (4 weeks)

Flat-plate 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, Different types of direct conversion cells, Use of direct conversion panels and the concept of service rendered.

**Chapter 5. Wind energy** (2 weeks)

Wind resources, Different types of wind turbines, Use of wind turbines,

**Chapter 6. Geothermal energy** (1 week)

Geothermal energy: Resources in Algeria and use,

**Chapter 7. Biomass** (1 week)

Biomass: Use of waste.

**Assessment method:**

Examination: 100%.

**Bibliographical references:**

1. B. Equer, J. Percebois, "Photovoltaic Solar Energy, 1: Physics and Technology of Photovoltaic Conversion," Ellipses, 1993.
2. P. Gipe, "Wind power: Renewable energy for home, farm, and business," Chelsea Green Publishing Co., 2004.
3. A. Filloux, "Integrating Renewable Energies," 2014.
4. J. Vernier, "Renewable energies," 2014.
5. B. Wiesenfeld, "Promises and Realities of Renewable Energy," 2013.
6. C. Dubois, "The guide to wind power, techniques and practices," Eyrolles, 2009.

7. D. Le Gourières, "Wind turbines: Theory, design, and practical calculations," Editions du Moulin Cadiou, 2008.
8. A. Damien, "Biomass Energy: Definitions, Resources, and Conversion Methods," 2013.
9. J. Lemale, Geothermal Energy, Dunod, 2012.
10. P. Van de Maele, Jean-François Rocchi. "Geothermal Energy and Heating Networks," Publisher(s): ADEME, BRGM, 2003.
11. R. H. Charlier and 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 and A. Monaco, "Development of Marine Resources," 2014.

### **III - Detailed program by subject S2**

**Semester: 2**

**Teaching unit: UEF 1.2.1**

**Subject 1: Cooling and drying**

**VHS: 67.5 hours (Lectures: 1.5 hours, Tutorials: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Course objectives**

Knowledge and thermodynamic analysis of new cooling processes, particularly those using renewable energies (absorption, adsorption, and ejector cycles) and various configurations, as well as analysis of various operating units such as absorbers, regenerators, etc. With regard to drying: knowledge of the characteristics of wet bodies, Mollier diagrams, various drying methods and related balances, as well as some industrial process diagrams and their descriptions.

### **Recommended prior knowledge**

Knowledge and mastery of the main principles of technical thermodynamics and heat transfer concepts. Ability to write mass, energy, and momentum or dynamic balances.

### **Course content**

- |   |                  |
|---|------------------|
| 1. General information on refrigeration and drying  | <b>(1 week)</b>  |
| 2. Cold chain   | <b>(1 week)</b>  |
| 3. Refrigerated production and distribution   | <b>(2 weeks)</b> |
| 4. Refrigeration plants   | <b>(1 week)</b>  |
| 5. Evaporator feeding methods   | <b>(1 week)</b>  |
| 6. Types of refrigeration circuits  | <b>(1 week)</b>  |
| 7. Sizing a mechanical compression refrigeration machine (mechanical compression, absorption, adsorption, ejectors) | <b>(2 weeks)</b> |
| 8. Hot air drying   | <b>(1 week)</b>  |
| 9. Oven drying, freeze drying   | <b>(1 week)</b>  |
| 10. Drying with superheated steam   | <b>(1 week)</b>  |
| 11. Heat pump drying  | <b>(1 week)</b>  |
| 12. Sizing a drying system  | <b>(2 weeks)</b> |

### **Assessment method**

Continuous work 40% and exam 60%

### **Bibliographic references**

1. Come D. The cold chain. Methods collection, Hermann Editeur des Sciences et des Arts, 1995.
2. Lemeste M., Lorient D., Simatos D. Water in food. Tec et Doc, Lavoisier, 2002.
3. Rapin P., Jacquard P. Refrigeration Technology. Dunod, 2004.
4. COSTIC. Replacement refrigerants. SEDIT, 2003.
5. Cabeza F. The basics of refrigeration. Didafrio, 2002.
6. Bernier J., and Tassone A. Refrigeration Technician's Guide, Intervention Manual - Maintenance - Troubleshooting - Substitutes for R12-R22-R502. Les éditions parisiennes (EDIPA), 2004.
7. P. Rapin and P. Jacquard. Refrigeration Form, Dunod, 2006
8. Tompress. Dehydration or drying of food: Techniques and recipes. Tom Press éditions, 296 pages

9. Vasseur J. Industrial drying: principles and equipment calculations - Convective drying using hot air (part 2). J2452 V1, Techniques de l'Ingénieur, 2010.

**Semester: 2**

**Teaching unit: UEF 1.2.1**

**Subject 2: Ventilation and Air Conditioning II**

**VHS: 45 hours (Lectures: 1.5 hours; Tutorials: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Course objectives**

Students will learn about air treatment in ventilation and air conditioning systems using water or steam, as well as drying using adsorbers and other methods, not to mention ionization, deodorization, and, above all, complex air treatment processes and their representation in h-x diagrams (correspondence between processes and treatment devices). They will learn about air conditioning systems and functional diagrams (centralized and individual systems), as well as the various devices used in HVAC systems (heating and cooling coils, filters, fans, washers, air humidifiers, etc.).

### **Recommended prior knowledge**

A good understanding of the Ventilation and Air Conditioning I course.

### **Course content**

- |   |                  |
|---|------------------|
| 1. AIR TREATMENT IN HVAC SYSTEMS                    | <b>(3 weeks)</b> |
| 2. AIR CONDITIONING SYSTEMS AND FUNCTIONAL DIAGRAMS | <b>(4 weeks)</b> |
| 3. EQUIPMENT USED IN HVAC SYSTEMS                   | <b>(4 weeks)</b> |
| 4. AUTOMATIC REGULATION OF HVAC SYSTEMS             | <b>(4 weeks)</b> |

### **Assessment method**

Continuous assessment: 40%; Exam: 60%.

### **Bibliographical references**

1. H. RIETSCHHELL and W. RAISS. Treatise on Heating and Air Conditioning, Volumes I and II. Dunod Edition, 1974, 676 p.
2. G. PORCHER. Course on Air Conditioning: Basics of Calculating Air Conditioning Systems. 7th edition, Les éditions parisiennes CFP, 1993.
3. Christian PESSEY. Heating and Air Conditioning. La Maison Rustique, Flammarion. 2000. 128 p.
4. R. CADIERGUES. Handbook of Climate Engineering, SEDIT, 2006

**Semester: 2**  
**Teaching unit: UEF 1.2.2**  
**Subject 4: Heating Systems**  
**VHS: 45 hours (Lectures: 1.5 hours, Tutorials: 1.5 hours)**  
**Credits: 4**  
**Coefficient: 2**

### Course objectives

Study of different types of heating systems (accelerated hot water, low and high-pressure steam, superheated water, radiation, air, heat pumps, convectors, etc.).

Students will learn how to calculate and install the various components of a boiler room (location, dimensions, chimney, expansion tank, pumps, boilers, water softener, heat exchangers, air vents, valves, manifolds, distributors, etc.), as well as operating and maintenance methods.

### Recommended prior knowledge

Heating I course and the laws of heat transfer and fluid mechanics.

### Course content

- |  |                  |
|--|------------------|
| 1. HEATING SYSTEMS (hot water, steam, superheated water, hot air, radiation) | <b>(2 weeks)</b> |
| 2. BOILERS AND BURNERS   | <b>(2 weeks)</b> |
| 3. CONNECTION OF PRIMARY AND SECONDARY CIRCUITS                              | <b>(2 weeks)</b> |
| 2. ADJUSTMENT. RECEIPT AND TESTING   | <b>(2 weeks)</b> |
| 4. BOILER ROOM   | <b>(3 weeks)</b> |
| 5. REGULATION AND AUTOMATIC CONTROL OF THE INSTALLATION                      | <b>(3 weeks)</b> |
| 6. OPERATION AND MAINTENANCE OF HEATING SYSTEMS                              | <b>(2 weeks)</b> |

### Assessment method

Continuous assessment: 40%; Exam: 60%.

### Bibliographical references

1. Le Recknagel, Practical Handbook of Climate Engineering, Volume 2: Heating and Domestic Hot Water Production, PYC Éditions Livres, 3rd edition, 1996.
2. Bouteloup J., Le Guay M., Ligen J., Air Conditioning, Volume 3.2: Hydraulic and Air Distribution, EDIPA Éditions Parisiennes, 2002.
3. Braude P., Domestic Hot Water, Engineering Techniques, Energy Engineering Treatise.
4. Bouteloup J., Le Guay M., Ligen J., Air Conditioning, Volume 2: Heating and Cooling Production, EDIPA Éditions Parisiennes, 1997.
5. Couillard D. and Bouige R., Heating, Ventilation, and Air Conditioning, Editions Eyrolles, 5<sup>th</sup> edition.
6. Georges DEUTSCH. *Central Heating*. Chihab-Eyrolles, 1996, 219p.
7. Jean-Marc GUILLOU. *Plumbing*. Chihab-Eyrolles edition, 1996, 135 p.
8. Christian PESSEY. Heating and Air Conditioning. La Maison Rustique, Flammarion. 2000. 128 p.
9. P. CHARDOT and P. PARROT. Practical Guide to the Costic Gas Burner, SEDIT2005.

**Semester: 2**  
**Teaching unit: UEF 1.2.2**  
**Subject 3: HVAC System Regulation**  
**VHS: 45 hours (Lectures: 3 hours; Practical work: 1.5 hours)**  
**Credits: 6**  
**Coefficient: 3**

### Teaching objectives

To learn about the different equipment and technologies used in climate control engineering.

### Recommended prior knowledge

Control systems, refrigeration systems, heating and air conditioning systems

### Course content

1. **Specific features of climate control in HVAC engineering** **(1 week)**
2. **Control applied to cooling** **(4 weeks)**  
 (Control of small machines and hermetic units, Vacuum control, Differential oil pressure switches, Electronic expansion valves, High-pressure control, Low-pressure control, Defrosting)
3. **Control applied to air conditioning** **(4 weeks)**  
 (Basic technology used in air conditioning, Air conditioning cabinet for computer rooms, Air handling unit)
4. **Control applied to heating** **(3 weeks)**
5. **Practical cases of regulation in real installations** **(3 weeks)**

### Assessment

Continuous assessment 40% and exam 60%.

### Bibliographic references

1. J. Desmons. *"Regulation in Climate Engineering."* Dunod, Paris, 2005, ISBN 2 10 048639 X.
2. Ph. DAVY de VIRVILLE. *"Regulation."* Les Editions Parisienne, 1994, ISBN 2-86 243 037-4.
3. E. BOILLOT. *"Continuous Control and Regulation."* Editions TECHNIP, ISBN 2-7108-0822-6.

**Semester: 2**

**Teaching unit: UEM 1.2**

**Subject 1: Use of software applied to industrial refrigeration and air conditioning**

**VHS: 45 hours (Lectures: 1.5 hours; Tutorials: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Teaching objectives**

The main objective is to enable students to use simulation software such as FLUENT or CFX under ANSYS and to put into practice all the theoretical knowledge they have acquired during their training to solve a real-world problem. Other simulation codes that may be used: Castem, PDEase.

### **Recommended prior knowledge**

Students must have a good grasp of numerical methods and a good understanding of physics in order to interpret the results.

### **Course content**

- |  |                  |
|--|------------------|
| 1. FLUENT or CFX software  | <b>(2 weeks)</b> |
| 2. Introduction to and mastery of the best (example: GAMBIT)             | <b>(2 weeks)</b> |
| 3. Introduction to and mastery of FLUENT or CFX                          | <b>(2 weeks)</b> |
| 4. Practical examples in the field of energy                             | <b>(2 weeks)</b> |
| 5. Presentation and interpretation of results                            | <b>(2 weeks)</b> |
| 6. Other software for calculating heating, air conditioning, and cooling | <b>(5 weeks)</b> |

### **Assessment**

Continuous assessment 40% + Exam 60%.

### **Bibliographic references**

Ansys Fluent Tutorial or documentation provided with FLUENT and GAMBIT.

**Semester: 2**

**Teaching unit: UEM 1.2**

**Subject 2: Air Conditioning Systems**

**VHS: 45 hours (Lectures: 1.5 hours, Practical work: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Course objectives**

Detailed study of different air conditioning systems. Students will gain in-depth knowledge of air conditioning systems used in domestic and commercial settings.

### **Recommended prior knowledge**

Ventilation and air conditioning, hydraulic networks, heating of residential buildings.

### **Course content**

- |  |                  |
|--|------------------|
| 1. Compact systems   | <b>(3 weeks)</b> |
| 2. Centralized systems   | <b>(4 weeks)</b> |
| • All-air systems  |                  |
| • Water-only system  |                  |
| • Air and water system   |                  |
| 3. Variable refrigerant flow system  | <b>(3 weeks)</b> |
| 4. Other types of systems (solar air conditioning, natural gas air conditioning, etc.) | <b>(3 weeks)</b> |

### **Assessment method**

Continuous assessment: 40%; Exam: 60%.

### **Practical work**

Split system inverter air conditioning bench and/or other air conditioning devices.

**(3 weeks)**

In this practical work, students must:

- Record the actual values (refrigerant pressure and temperature) using measuring devices installed on the bench
- Measure the properties of the air using an electronic device (temperature and humidity) at the supply and return air vents
- Perform energy assessments
- Calculate actual and theoretical COPs

### **Bibliographical references**

1. Bouteloup J., Le Guay M., Ligen J., Air Conditioning and Air Conditioning, Volume 4: Systems, EDIPA Éditions Parisiennes, 1998.
2. ASHRAE Handbook, HVAC systems and equipment, 2016.
3. Handbook of Air Conditioning System Design, Carrier Air Conditioning Company.
4. Stanford H. W., HVAC water chillers and cooling towers, Marcel DeKker Inc., 2003.

**Semester: 2**  
**Teaching unit: UEM 1.2**  
**Subject 3: Practical work on HVAC control systems**  
**VHS: 15 hours (practical work: 1 hour)**  
**Credits: 1**  
**Coefficient: 1**

### **Teaching objectives**

The objective is to introduce students to the problems posed by the synthesis of a control loop and the control techniques most commonly used in industrial systems, whether analog or digital.

### **Recommended prior knowledge**

Fundamental concepts of control and instrumentation

### **Course content**

- |   |                  |
|---|------------------|
| 1. Control applied to refrigeration                 | <b>(3 weeks)</b> |
| 2. Regulation applied to air conditioning           | <b>(4 weeks)</b> |
| 3. Regulation applied to heating                    | <b>(4 weeks)</b> |
| 4. Practical cases of control in real installations | <b>(4 weeks)</b> |

### **Assessment method**

Continuous assessment: 100%.

### **Bibliographical references**

1. J. Desmons. "*Régulation en Génie Climatique*" (*Control in Climate Engineering*). Dunod, Paris, 2005, ISBN 2 10 048639 X.
2. Ph. DAVY de VIRVILLE. "*Regulation.*" Les Editions Parisienne, 1994, ISBN 2-86 243037-4.
3. E. BOILLOT. "*Continuous Control and Regulation.*" Editions TECHNIP, ISBN 2- 7108 0822-6.

**Semester: S2**

**Teaching unit: 1.2.1**

**Subject: Elements of applied artificial intelligence**

**VHS: 45 hours (1.5 hours of lectures, 1.5 hours of practical work)**

**Credits: 2**

**Coefficient: 2**

**Targeted skills:**

- Identify opportunities for artificial intelligence in engineering sciences
- Understand the ethical implications of AI and best practices for its use.
- Ability to use AI techniques in problem solving

**Objectives:**

- Mastery of AI algorithms
- Introduction to the fundamental concepts, tools, and applications of modern artificial intelligence, with an emphasis on practical use with Python and its libraries.
- In-depth study of the Python language.
- Understanding AI approaches to problem solving

**Prerequisites:**

Advanced Python programming

**Required materials:**

- A computer with Python installed,
- Python libraries: NumPy, Pandas, Scikit-learn, Matplotlib, os.listdir, os.path.exists, os.mkdir, os.rmdir, Matplotlib, Seaborn, Plitly, Request, Beautiful Soup, Tkinter, PyQt, etc.
- Tensorflow, PyTorch, etc.

**Course content:**

**Chapter 1: Introduction to artificial intelligence (AI) (1 week)**

1. Definitions and fields of application of AI.
2. Historical evolution of AI.
3. Introduction to the main areas:
  - Machine learning
  - Deep learning

**Chapter 2: Basic mathematics for AI (01 week)**

1. **Linear algebra:** vectors, matrices, products, norms.
2. **Probability & statistics:**
  - Variables, expectation, variance.
  - Common distributions: normal, binomial, uniform.
3. **Simple linear regression:**
  - Formulation, cost, optimization.
  - Implementation with **Scikit-learn**.
4. **Exercises:**
  - Matrix manipulation with the NumPy library (Python)
  - Exercise on linear regression (using a Python library such as Scikit-learn, for example)
  - Explaining the Matplotlib library (Python)

### Chapter 3: Machine learning (03 weeks)

1. Key concepts: Data, models, features, labels, generalization.
2. Phases of a learning pipeline: training, validation, testing.
3. Types of learning:
  - Supervised
  - Unsupervised
  - By reinforcement (*overview*)
4. **Exercises:**
  - Reinforce the concepts covered in class
  - ....

### Chapter 4: Supervised classification (3 weeks)

1. Principle of training a simple classification model:
2. Models and algorithms:
  - SVM (Support Vector Machine)
  - Decision trees
3. Performance evaluation:
  - Confusion matrix, precision, recall, F1 score.
5. **Exercises:**
  - Explain how to use Scikit-learn?
  - Comparison of several models on a dataset
  - ....

### Chapter 5: Unsupervised learning

1. The concept of clustering.
2. Algorithms:
  - **K-means**
  - DBSCAN (Density-Based Spatial Clustering of Applications with Noise)
3. 2D visualization and interpretation of results.
4. **Exercises:**
  - Explain how to use a clustering algorithm on a dataset
  - Explain how to visualize clusters.
  - ...

### Chapter 6: Neural networks

1. Architecture of a neural network:
  - Perception,
  - Layers and hidden layers, weights, bias.
  - Activation function: ReLU, Sigmoid, Softmax, etc.
  - Application exercises
2. Introduction to **Deep Learning:**
  - Concept of deep layers.
  - Introduction to convolutional neural networks (CNN)

**3. Exercises:**

- Explain Tensorflow and PyTorch
- Analyze a text dataset and predict sentiments
- ...

**Chapter 6: Introduction to Neural Networks****Chapter 7: Mini project (supervised personal work outside of class):**

Create a complete classification or clustering model, including preprocessing, training, and visualization; choose and complete a project from start to finish from among the following (to be distributed at the beginning of the semester):

- Handwritten character recognition
- Prediction of natural disasters
- Develop a chatbot capable of answering frequently asked questions about a company in a natural way.
- Develop a system capable of distinguishing between normal machine sounds and those indicating an anomaly (defective bearing, excessive vibration, etc.)
- Develop a system (mini AI) capable of analyzing the sentiments expressed in social media posts about a product, brand, or event.
- ...

**Practical work:****Practical assignment 01: Initialization****Practical assignment 02:**

- Implement a simple regression with Scikit-learn visualization with Matplotlib (for example)
- Visualize the results with Matplotlib
- ...

**TP 03:**

- Machine learning pipeline and data separation
- Further exploration of concepts covered in class

**Practical assignment 04:**

- Using Scikit-learn to train a simple classification model
- .....

**Lab 05:**

- Implementing a clustering algorithm on a dataset
- Visualizing clusters: Unsupervised clustering (K-means, DBSCAN).
- ....

**TP 06:**

- Build a simple neural network with TensorFlow, PyTorch, or Keras
- Build a simple CNN to classify images (example: MNIST dataset)
- ...

**Assessment method:**

**exam 60%, CC=40%**

**Bibliography:**

- Ganascia, J.Gabriel (2024): AI Explained to Humans. Paris, France—Le Seuil Publishing.
- Anglais, Lise, Dilhac, Antione, Dratwa, Jim et al. (2023): Ethics at the Heart of AI. Quebec Obvia.
- J. Robert (2024): Natural Language Processing (NLP): Definition and Principles – Datasciences. Link: <https://datascientest.com/introduction-au-nlp-natural-language-processing>
- What is natural language processing? Link: <https://aws.amazon.com/fr/what-is/nlp/>
- M.Journe: Elements of Discrete Mathematics – Ellipses
- F.Challet: Deep learning with Python – Eyrolles
- H. Bersini (2024): Artificial Intelligence in Practice with Python – Eyrolles
- B.Prieur (2024): Automatic Natural Language Processing with Python – Eyrolles
- V. Mathivet (2024): Implementation in Python with Scikit-learn – Eyrolles
- G. Dubertret (2023): Introduction to Cryptography with Python – Eyrolles
- S.Chazallet (2023): Python 3 – The Fundamentals of the Language – Eyrolles
- H. Belhadef, I. Djemal: TALN Method – University of Msila Course – Algeria

**Semester: 2**

**Teaching unit: UET 1.2**

**Subject: Compliance with standards and rules of ethics and integrity.****VHS: 22.5 hours (Classes: 1.5 hours)****Credits: 1****Coefficient: 1**Teaching objectives:

To develop students' awareness of ethical principles and rules governing university life and the world of work. To raise their awareness of the importance of respecting and valuing intellectual property. To explain the risks of moral evils such as corruption and how to combat them, and to alert them to the ethical issues raised by new technologies and sustainable development.

Recommended prior knowledge:

Ethics and professional conduct (the fundamentals)

Course content:

## A. Respect for the rules of ethics and integrity

1. Reminder of the MESRS Ethics and Professional Conduct Charter: Integrity and honesty. Academic freedom. Mutual respect. Requirement for scientific truth, objectivity, and critical thinking. Fairness. Rights and obligations of students, teachers, administrative and technical staff.

## 2. Ethical and responsible research

- Respect for ethical principles in teaching and research
- Responsibilities in teamwork: Professional equality of treatment. Conduct against discrimination. The pursuit of the public interest. Inappropriate conduct in the context of collective work
- Adopting responsible conduct and combating abuses: Adopting responsible conduct in research. Scientific fraud. Conduct against fraud. Plagiarism (definition of plagiarism, different forms of plagiarism, procedures to avoid unintentional plagiarism, detection of plagiarism, sanctions against plagiarists, etc.). Falsification and fabrication of data.

## 3. Ethics and professional conduct in the workplace:

Legal confidentiality in business. Loyalty to the company. Responsibility within the company, conflicts of interest. Integrity (corruption in the workplace, its forms, consequences, ways of combating it, and sanctions against corruption)

## B- Intellectual property

## I- Fundamentals of intellectual property

- 1- Industrial property. Literary and artistic property.
- 2- Rules for citing references (books, scientific articles, conference papers

at conferences, theses, dissertations, etc.)

## II- Copyright

## 1. Copyright in the digital environment

Introduction. Copyright in databases, copyright in software. The specific case of free software.

## 2. Copyright on the internet and in e-commerce

Domain name law. Intellectual property on the internet. E-commerce website law. Intellectual property and social networks.

## 3. Patents

Definition. Rights in a patent. Usefulness of a patent. Patentability. Patent applications in Algeria and worldwide.

## III- Protection and promotion of intellectual property

How to protect intellectual property. Violation of rights and legal tools. Exploitation of intellectual property. Protection of intellectual property in Algeria.

## C. Ethics, sustainable development, and new technologies

Link between ethics and sustainable development, energy saving, bioethics, and new technologies (artificial intelligence, scientific progress, humanoids, robots, drones,

Assessment method:

Exam: 100%

Bibliographic references:

1. Charter of Academic Ethics and Professional Conduct, [https://www.mesrs.dz/documents/12221/26200/Charte+fran\\_ais+d\\_f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce](https://www.mesrs.dz/documents/12221/26200/Charte+fran_ais+d_f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce)
2. Decree No. 933 of July 28, 2016 establishing rules relating to the prevention and combating of plagiarism
3. E. Prairat, De la déontologie enseignante (On Teaching Ethics). Paris, PUF, 2009.
4. Racine L., Legault G. A., Bégin, L., Ethics and Engineering, Montreal, McGraw Hill, 1991.
5. Siroux, D., Ethics: Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004, pp. 474-477.
6. Medina Y., Ethics: What Will Change in Business, Éditions d'Organisation, 2003.
7. Didier Ch., Penser l'éthique des ingénieurs (Thinking about the ethics of engineers), Presses Universitaires de France, 2008.
8. Gavarini L. and Ottavi D., Editorial. Professional ethics in training and research, Research and Training, 52 | 2006, 5-11.
9. Caré C., Morals, Ethics, Professional Conduct. Administration and Education, 2nd quarter 2002, no. 94.
10. Jacquet-Francillon, François. Concept: Professional Ethics. Letélémaque, May 2000, no. 17
11. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
12. Galloux, J.C., Industrial Property Law. Dalloz 2003.
13. Wagret F. and J-M., Patents, Trademarks, and Industrial Property. PUF 2001
14. Dekermadec, Y., Innovating through patents: a revolution with the internet. Insep 1999
15. AEUTBM. Engineers at the heart of innovation. Belfort-Montbéliard University of Technology
16. <http://www.app.asso.fr/>
17. <http://ressources.univ-rennes2.fr/propriete-intellectuelle/cours-2-54.html>
18. Fanny Rinck and Léda Mansour "Literacy in the digital age: copy-and-paste among students" University of Grenoble 3 and University of Paris Ouest Nanterre La Défense Nanterre, France
19. The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)
20. Alain Bensoussan White Paper – Open Science in a Digital Republic Directorate of Scientific and Technical Information CNRS
21. Copyright in the cultural industries. - Cheltenham: E. Elgar, 2002. - XXII-263 p.
22. Similarity detection software: a solution to electronic plagiarism? Report of the Working Group on Electronic Plagiarism presented to the CREPUQ Subcommittee on Pedagogy and ICT
23. Emanuela Chiriac, Monique Filiatrault, and André Régimbald. "Student Guide: Intellectual Integrity Plagiarism, Cheating, and Fraud... How to Avoid Them and, Above All, How to Cite Your Sources Properly" 2014
24. Publication by the University of Montreal. "Plagiarism Prevention Strategies," Integrity, Fraud, and Plagiarism, 2010
25. Pierrick Malissard "Intellectual Property: Origin and Evolution" 2010.
26. The World Intellectual Property Organization website [www.wipo.int](http://www.wipo.int).

### **III - Detailed program by subject S3**

**Semester: 3**  
**Teaching unit: UEF 2.1.1**  
**Subject 1: Heat exchanger**  
**VHS: 45 hours (Lectures: 1.5 hours; Tutorials: 1.5 hours)**  
**Credits: 4**  
**Coefficient: 2**

### Teaching objectives

Master the calculations and sizing of different types of heat exchangers in order to achieve the optimal design for the most suitable exchange device.

### Recommended prior knowledge

Heat and mass transfer, fluid mechanics

### Course content

- |   |                  |
|---|------------------|
| 1. General  | <b>(1 week)</b>  |
| 2. Convective heat transfer coefficient without phase change in heat exchangers | <b>(2 weeks)</b> |
| 3. Convective heat transfer coefficient with phase change                       | <b>(2 weeks)</b> |
| 4. Heat exchanger technology  | <b>(2 weeks)</b> |
| 5. Heat exchanger performance and calculation                                   | <b>(2 weeks)</b> |
| 6. Efficiency of an exchanger   | <b>(2 weeks)</b> |
| 7. Design examples  | <b>(2 weeks)</b> |
| 8. Optimization and energy integration of heat flows in exchanger networks      | <b>(2 weeks)</b> |

### Assessment

Continuous assessment: 40%; Exam: 60%.

### Bibliography

1. D. Q. KERN, Process heat transfer. McGraw-Hill: New York, 1984, 871 p.
2. B. PIERRE, Dimensioning of heat exchangers. Revue Gén. Therm. Fr., 1983, p. 587-615.
3. Ch. BOUGRIOU, Study of heat transfer by condensation of humid air on finned tubes: INSA Lyon ISAL87 Doctorate, 1991, 183p.
4. GNIELINSKI, V. New equations for heat transfer in turbulent pipe and channel flow. IntChem. Eng., 1976, Vol.16, No.2, pp.359-368.
5. GNIELINSKI, V. et al. Banks of plain and finned tubes, single-phase convective heat transfer. Heat Exchanger Design Handbook., 1983, Vol. 2, pp. 2.5.3.1-2.5.3.16.

**Semester: 3**  
**Teaching unit: UEF 2.1.1**  
**Subject 2: Industrial Ventilation and Environmental Protection**  
**VHS: 45 hours (Lectures: 1.5 hours; Tutorials: 1.5 hours)**  
**Credits: 4**  
**Coefficient: 2**

### Course objectives

To give students a good understanding of the aerodynamic design of industrial facilities and teach them how to deal with pollution and loads in industrial premises.

### Recommended prior knowledge

Ventilation and air conditioning systems, acoustics, environment

### Course content

- |   |                  |
|---|------------------|
| 1. General  | <b>(1 week)</b>  |
| 2. Ventilation systems for industrial halls with heat and humidity release            | <b>(2 weeks)</b> |
| 3. Ventilation systems for industrial halls with toxic gas and vapor emissions        | <b>(3 weeks)</b> |
| 4. Ventilation systems for industrial halls with dust emissions<br>dust               | <b>(2 weeks)</b> |
| 5. Air pollution filtration systems   | <b>(2 weeks)</b> |
| 6. Atmospheric pollution by substances discharged from industrial ventilation systems | <b>(3 weeks)</b> |
| 7. Noise control using ventilation systems  | <b>(2 weeks)</b> |

### Assessment method

Continuous assessment: 40%; Exam: 60%.

### Bibliographical references

1. H. RIETSCHHELL and W. RAISS. Treatise on Heating and Air Conditioning, Volumes I and II, Dunod Edition, 1974, 676 p.
2. G. PORCHER. Course on Air Conditioning: Basics of Calculating Air Conditioning Systems. 7th edition, Les éditions parisiennes CFP, 1993.
3. Christian PESSEY. Heating and Air Conditioning. La Maison Rustique, Flammarion. 2000. 128 p.
4. R. CADIERGUES. Handbook of Climate Engineering, SEDIT, 2006
5. T. SALOMON and C. AUBERT. Cool without air conditioning, Terre vivante, 2004
6. M. BOSSARD. Air Conditioning in the Home, Foucher, 2002
7. Ph. COURTIN. Air Conditioning, Air Conditioning - Volume 5 - Calculating Discharges, Les éditions parisiennes (EDIPA), 2002

**Semester: 3**

**Teaching unit: UEF 2.1.1**

**Subject 3: Air conditioning and industrial refrigeration design office**

**VHS: 22.5 hours (Lectures: 1.5 hours)**

**Credits: 2**

**Coefficient: 1**

### **Teaching objectives**

Acquire knowledge of design and reproduction based on plans in order to calculate heat loss, thermal loads, fluid networks, and sizing for the selection of equipment and air conditioning systems.

### **Recommended prior knowledge**

Basic concepts of air conditioning and instrumentation.

### **Course content**

#### **1. Air conditioning design office**

**(7 weeks)**

Reproduction of plans – building drawings, network drawings

Application of winter balance – calculation of heat loss, dimensioning

Selection of equipment

Application of summer assessment – calculation of heat gains

Choice of air conditioning system, Cost evaluation

#### **2. Industrial refrigeration design office**

**(8 weeks)**

-Cold room design, sizing, regulation, equipment selection, performance evaluation

-Calculation of thermal loads

-Fluid network calculation

### **Assessment method**

Exam: 100%.

### **Bibliographic references**

1. Book: "Froid industriel" (Industrial Refrigeration), 2nd edition, Author: Francis MEUNIER, Publisher: Dunod/Revue pratique du froid (2005), ISBN-10: 210048527X, ISBN-13: 9782100053018.
2. G. PORCHER. Air Conditioning Course: Basics of Air Conditioning System Calculation.<sup>7th</sup>edition, Les éditions parisiennes CFP, 1993.

**Semester: 3**

**Teaching unit: UEF 2.1.2**

**Subject 1: Control and automation of energy installations**

**VHS: 45 hours (Lectures: 1.5 hours; Tutorials: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Course objectives**

Introduce students to the problems posed by control loop synthesis and the automation techniques most commonly used in energy systems in order to optimize control problems in industrial environments.

### **Recommended prior knowledge**

Regulation, control, automation.

### **Course content**

1. Industrial programmable logic controller programming (Grafcet) **(2 weeks)**
2. Functional diagram, block diagram **(1 week)**
3. Basic modeling (integrator, 1<sup>st</sup>order, 2<sup>nd</sup>order, filter) **(2 weeks)**
4. Concept of control (open loop, closed loop) **(2 weeks)**
5. Performance criteria (stability, overshoot, static error, rise time, etc.) **(2 weeks)**
6. Control (P, PI, PID) **(2 weeks)**
7. Corrector synthesis method (Ziegler and Nichols, frequency synthesis of a corrector) **(2 weeks)**
8. Introduction to digital control. **(2 weeks)**

### **Assessment method:**

Continuous assessment 40% and exam 60%.

### **Bibliographic references**

Book: "Industrial Regulation," 2nd edition, Author: Emmanuel GODOY, Publisher: Dunod/L'usine nouvelle (2007), EAN-13: 9782100497393.

**Semester: 3**  
**Teaching unit: UEF 2.1.2**  
**Subject 2: Cryogenic processes**  
**VHS: 45 hours (Lectures: 1.5 hours; Tutorials: 1.5 hours)**  
**Credits: 4**  
**Coefficient: 2**

### **Course objectives**

To deepen technical and practical knowledge, enabling a comprehensive understanding of gas refrigeration and liquefaction processes.

### **Recommended prior knowledge**

Cryogenics, refrigeration systems.

### **Course content**

- |  |           |
|--|-----------|
| 1. General                                     | (1 week)  |
| 2. Production of low and very low temperatures | (2 weeks) |
| 3. Cryogenic exchangers                        | (2 weeks) |
| 4. Compressors and expanders                   | (2 weeks) |
| 5. Joule-Thomson valve                         | (1 week)  |
| 6. Isoenthalpic expansion cycles               | (1 week)  |
| 7. Isentropic expansion cycles                 | (1 week)  |
| 8. Vapor compression cycle                     | (1 week)  |
| 9. Practical liquefiers                        | (2 weeks) |
| 10. Cryogenic refrigerators                    | (2 weeks) |

### **Assessment method**

Continuous assessment 40% and exam 60%.

### **Bibliographic references**

Book: "Gas Liquefaction Techniques - Cryogenic Exchangers," Author: PETIT Pierre, Publisher: Ecole Nationale des Mines de Paris.

**Semester: 3**

**Teaching unit: UEM 2.1**

**Subject 1: Refrigeration systems**

**VHS: 45 hours (Lectures: 1.5 hours; Practical work: 1.5 hours)**

**Credits: 4**

**Coefficient: 2**

### **Course objectives**

Acquire in-depth knowledge of the various refrigeration cycles used in industrial refrigeration in order to calculate and dimension the various components.

### **Recommended prior knowledge**

Refrigeration systems, thermodynamics, heat transfer.

### **Course content**

- |  |           |
|--|-----------|
| 1. General   | (1 week)  |
| 2. Two-stage cycles with full injection                            | (1 week)  |
| 3. Two-stage cycles with partial injection                         | (1 week)  |
| 4. Two-stage cycles without intermediate bottle                    | (1 week)  |
| 5. Choice of intermediate pressure                                 | (1 week)  |
| 6. Compound compressor cycles                                      | (2 weeks) |
| 7. Compressor cycles with supercharger port                        | (2 weeks) |
| 8. Two-stage cycles with total injection at two temperature levels | (2 weeks) |
| 9. Two-stage cycles with booster compressor                        | (2 weeks) |
| 10. Cascade cycles   | (2 weeks) |

### **Assessment method**

Continuous assessment 40% and exam 60%.

### **Bibliographic references**

Book: "Froid industriel" (Industrial Refrigeration), 2nd edition, Author: Francis MEUNIER, Publisher: Dunod/Revue pratique du froid (2005), ISBN-10: 210048527X, ISBN-13: 9782100053018.

**Semester: 3**  
**Teaching unit: UEM 2.1**  
**Subject 2: Operational Research**  
**VHS: 37.5 hours (Lectures: 1.5 hours; Practical work: 1 hour)**  
**Credits: 3**  
**Coefficient: 2**

### **Course objectives**

To provide the basis for formulating and using mathematical models to master the laws of optimization of operating parameters and to cover a set of models of different types giving rise to various solution techniques applicable in energy fields.

### **Recommended prior knowledge**

Basic concepts of real analysis and linear algebra.

### **Course content**

- |                                    |                  |
|------------------------------------|------------------|
| 1. General                         | <b>(1 week)</b>  |
| 2. Linear programming              | <b>(2 weeks)</b> |
| 3. Linear programming in integers  | <b>(2 weeks)</b> |
| 4. Constraint programming          | <b>(2 weeks)</b> |
| 5. Metaheuristics                  | <b>(2 weeks)</b> |
| 6. Nonlinear programming           | <b>(2 weeks)</b> |
| 7. Dynamic programming             | <b>(2 weeks)</b> |
| 8. Reliability and fault tolerance | <b>(2 weeks)</b> |

### **Assessment**

Continuous assessment 40% and exam 60%.

### **Bibliographic references**

1. Exercises and solved problems in operational research: Volume 1, Graphs: their uses, their algorithms, Dunod 2002.
2. J-F. Hêche, T. M. Liebling, D. de Werra Operational Research for Engineers – II, Stochastic Models, Presses Polytechniques et Universitaires Romandes (PPUR).
3. R. Faure. PRECIS OF OPERATIONS RESEARCH – Methods and Application Exercises, Dunod.
4. Operations Research - Volume 1 Optimization Methods, Author: Jacques TEGHEM, Publisher: Ellipses (2012), ISBN-10: 2729875093, ISBN-13: 9782729875091.

**Semester: 3**

**Teaching unit: UEM 2.1**

**Subject 3: Practical work: Troubleshooting refrigeration and air conditioning systems**

**VHS: 22.5 hours (practical work: 1.5 hours)**

**Credits: 2**

**Coefficient: 1**

**Teaching objectives**

Master common electrical or fluidic faults in a refrigeration system.

**Recommended prior knowledge**

Refrigeration systems, thermodynamics, electrical engineering.

**Course content**

Detect electrical or fluidic faults in a refrigeration system. Charge and discharge refrigerant from a refrigeration machine  
**(15 weeks)**

**Assessment**

100% continuous assessment.

**Semester: 3**  
**Teaching unit: UET 2.1**  
**Subject: Documentary research and thesis design**  
**VHS: 22.5 hours (Classes: 1.5 hours)**  
**Credits: 1**  
**Coefficient: 1**

### **Teaching objectives**

To provide students with the tools they need to research useful information for their final project. To help them through the various stages involved in writing a scientific paper. To emphasize the importance of communication and teach them how to present their work in a rigorous and educational manner.

### **Recommended prior knowledge**

Writing methodology, presentation methodology.

### **Course content**

#### **Part I: Documentary research:**

##### **Chapter I-1: Defining the topic**

**(2 weeks)**

- Title of the topic
- List of keywords related to the topic
- Gather basic information (acquisition of specialized vocabulary, meaning of terms, linguistic definition)
- Information sought
- Assessing your knowledge in the field

##### **Chapter I-2: Selecting sources of information**

**(2 Weeks)**

- Types of documents (books, theses, dissertations, journal articles, conference proceedings, audiovisual documents, etc.)
- Type of resources (libraries, Internet, etc.)
- Assess the quality and relevance of information sources

##### **Chapter I-3: Locating documents**

**(1 week)**

- Search techniques
- Search operators

##### **Chapter I-4: Processing information**

**(2 Weeks)**

- Organizing work
- Initial questions
- Summary of selected documents
- Links between different parts
- Final plan for documentary research

##### **Chapter I-5: Presentation of the bibliography**

**(1 Week)**

- Systems for presenting a bibliography (Harvard system, Vancouver system, mixed system, etc.)
- Presentation of documents.
- Citing sources

## Part II: Thesis design

### Chapter II-1: Thesis outline and stages (2 Weeks)

- Identifying and defining the topic (Abstract)
- Thesis problem and objectives
- Other useful sections (Acknowledgments, List of abbreviations, etc.)
- The introduction (*Write the introduction last*)
- State of the art
- Formulation of hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- Conclusion and outlook
- Table of Contents
- Bibliography
- Appendices

### Chapter II-2: Writing techniques and standards (2 Weeks)

- Formatting. Numbering of chapters, figures, and tables.
- The cover page
- Typography and punctuation
- Writing. Scientific language: style, grammar, syntax.
- Spelling. Improving general language skills in terms of comprehension and expression.
- Saving, securing, and archiving data.

### Chapter II-3: Workshop: Critical review of a manuscript (1 week)

### Chapter II-4: Oral presentations and defenses (1 week)

- How to present a poster
- How to present an oral communication.
- Defending a thesis

### Chapter II-5: How to avoid plagiarism? (1 Week)

(Formulas, sentences, illustrations, graphs, data, statistics, etc.)

- Quotations
- Paraphrasing
- Provide the complete bibliographic reference

### Assessment method

Exam: 100%.

### Bibliographic references

1. M. Griselin et al., *Guide de la communication écrite, 2nd edition, Dunod, 1999.*
2. J.L. Lebrun, *Practical Guide to Scientific Writing: How to Write for the International Scientific Reader, Les Ulis, EDP Sciences, 2007.*
3. A. Mallender Tanner, *ABC de la rédaction technique: modes d'emploi, notices d'utilisation, aides en ligne, Dunod, 2002.*
4. M. Greuter, *Writing Your Thesis or Internship Report, L'Etudiant, 2007.*

5. *M. Boeglin, Reading and Writing at University: From Chaos of Ideas to Structured Text, L'Etudiant, 2005.*
6. *M. Beaud, The Art of the Thesis, Editions Casbah, 1999.*
7. *M. Beaud, The Art of Writing a Thesis, La découverte, 2003.*
8. *M. Kalika, The Master's Thesis, Dunod, 2005.*

**Semester: 3**  
**Teaching unit: UET 2.1**  
**Subject 1: Reverse Engineering**  
**VHS: 45 hours (Lecture: 1.5 hours and Workshop: 1.5 hours)**  
**Credits: 2**  
**Coefficient: 2**

### Teaching objectives:

- Understand the principles and objectives of reverse engineering (RE) in the field of science and technology (ST).
- Become familiar with RE tools and methods in the relevant field.
- Understand the value and ethics of RE principles in product design, manufacturing, and quality assurance.
- Encourage critical thinking, technical curiosity, reasoned reverse engineering, and innovation.
- Learn to analyze, document, and model an existing system without initial documentation.

### Targeted skills

- Break down and analyze an existing system.
- Accurately reproduce a technical diagram or 3D model from an existing product,
- Apply diagnostic and simulation tools,
- Work in a group on an exploratory project,
- Identify the legal limitations of reverse engineering

### Adaptability to specializations in the field of Science and Technology: e

- All specializations in the ST field are concerned, as follows
- Examples of tasks: Digital technical documentation, technology watch results, technical project management, collaboration on plans, report analysis, understanding of industrial processes, production data monitoring, reporting techniques, prototyping, testing)

### Prerequisites:

- Fundamental knowledge in the specialty.

### Course content:

#### 1. Introduction to reverse engineering

- History, legal and ethical issues of RE,
- Definitions and fields of application: Approaches (hardware, software, processes, etc.)
- Fields: maintenance, remanufacturing, cybersecurity, competitive intelligence

#### 2. General methodology

- Analysis of a black box system
- Functional decomposition
- Block diagrams, inputs/outputs, energy or information flows

#### 3. Hardware reverse engineering

- Electronic cards: visual inspection, component identification

- Use of tools: multimeter, oscilloscope, logic analyzer
- Recognition of electronic schematics
- Reconstruction of schematics in KiCad/Proteus

#### 4. Software reverse engineering

- Static analysis of binaries (e.g., .exe, .hex)
- Decompilation, disassembly (introduction to Ghidra, IDA Free, or Hopper)
- Observation of behaviors: sniffing, monitoring (e.g., Wireshark)
- Microcontrollers: flash memory reading, firmware extraction

#### 5. Mechanical reverse engineering

- 3D scanning: scanner, manual measurements
- Reproduction of CAD models from existing parts
- Software used: SolidWorks, Fusion360

#### 6. Security and intrusion detection

- Reverse engineering in cybersecurity: malware detection, vulnerabilities
- Software signing, protections against RE (obfuscation, encryption)

#### 7. Real-world case studies

- Analysis of an obsolete or unknown product (mouse, power supply, Bluetooth module, etc.)
- Example of reverse engineering of a mechanical part or simple system (fan, case)

#### Practical work examples (based on the 4 engineering disciplines)

- **Electrical Engineering:**

- Reverse engineering of an electronic module without a diagram
- Example: Bluetooth module, time delay relay
- Objectives: identify how it works, draw the diagram, propose an improved version.
- Identification of components (ICs, transistors, resistors, etc.).
- Use of tools: multimeter, oscilloscope, logic analyzer.
- Reading and extracting firmware from a microcontroller.
- Introduction to electronic counterfeit detection.

- **Mechanical Engineering:**

- Reverse engineering of a simple mechanism
- Examples: manual pump, torque wrench, mini-press.
- Mechanical disassembly of a system (pump, gear, jack, etc.).
- Measurements and reconstruction of plans or 3D models using CAD software (SolidWorks, Fusion360).
- Identification of materials and manufacturing methods.
- Functional simulation based on the recreated model.

- **Civil engineering:**

- Analysis of existing structures without plans (walls, slabs, structures, etc.).
- Examples: metal staircase, window sill, formwork)
- Study and reverse engineering of an existing structural element.
- Identification of materials, assemblies, and constraints.
- Modeling of the structure using Revit, AutoCAD, or SketchUp.
- Study of the rehabilitation or reproduction of old structural elements.

- **Process engineering:**

- Reverse engineering of a laboratory module
- Examples: instruments, distillation, filtration, exchangers, simple reactors, etc.
- Analysis of existing industrial systems (distillation column, exchanger, reactor, etc.).
- Reconstruction of PFD and PID diagrams based on observation of an installation.
- Identification of sensors, actuators, and control devices.
- Study of material/energy flows in a process.

**Assessment method:**

**Exam: 60%, CC: 40%**

**Bibliographic references:**

- Reverse Engineering for Beginners – Dennis Yurichev (free online)
- The IDA Pro Book – Chris Eagle (software)
- Practical Reverse Engineering – Bruce Dang
- Documentation:
  - <https://ghidra-sre.org>
  - <https://www.kicad.org>
  - <https://www.autodesk.com/products/fusion-360>