الجمهورية الجزائرية الديمقراطية الشعبية People's Democratic Republic of Algeria
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research
اللجنة البيداغوجية الوطنية لميدان العلوم والتكنولوجيا
National Educational Committee for the field of Science and Technology

ACADEMIC MASTER HARMONIZE

National program

2022 update

Domain	Sector	Speciality
Science And Technologies	***Mechanical Engineering***	***Energy***

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National Educational Committee for the field of Science and Technology

ماستر أكاديمي
مواءمة

برنامج وطني

تحيين 2022

الميدان	الفرع	التخصص
علوم وتكنولوجيا	هندسة ميكانيكية	طاقوية

I–Master's identity sheet

Access conditions

(Indicate the license specialties which can give access to the Master)

Sector	Harmonized Master	Access licenses to the master's degree	Ranking according to license compatibility	Coefficient assigned to the license
Mechanical Engineering	**Energy**	Energy	**1**	**1.00**
		Aeronautics	**2**	**0.80**
		Mechanical construction	**2**	**0.80**
		Process Engineering	**3**	**0.70**
		Other ST licenses	**4**	**0.60**

II – Half-yearly teaching organization sheets of the specialty

Semester 1

Teaching unit	Materials / Titled	Credits	Coefficient	Weekly hourly volume: Course	T.D.	TP	Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method: Continuous monitoring	Exam
Fundamental EU Code: UEF 1.1.1 Credits: 8 Coefficients: 4	In-depth fluid mechanics	4	2	1h30	1h30		45:00	55:00	40%	60%
	Thermal machines	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 1.1.2 Credits: 10 Coefficients: 5	Deep heat and mass transfer	6	3	3:00 a.m.	1h30		67h30	82h30	40%	60%
	In-depth numerical methods	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 1.1 Credits: 9 Coefficients: 5	Instrumentation and measurements	4	2	1h30		1h30	45:00	55:00	40%	60%
	TP Numerical methods	2	1			1h30	10:30 p.m.	27:30	100%	
	TP thermal machines	2	1			1h30	10:30 p.m.	27:30	100%	
	TP MDF	1	1			1h00	3:00 p.m.	10:00 a.m.	100%	
EU Discovery Code: UED 1.1 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
Transversal EU Code: UET 1.1 Credits: 1 Coefficients: 1	Technical English and terminology	1	1	1h30			10:30 p.m.	02:30		100%
Total semester 1		**30**	**17**	**1:30 p.m.**	**6:00 a.m.**	**5:30 a.m.**	**375h00**	**375h00**		

Semester 2

Teaching unit	Materials: Titled	Credits	Coefficient	Weekly hourly volume: Course	T.D.	TP	Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method: Continuous monitoring	Exam
Fundamental EU Code: UEF 1.2.1 Credits: 10 Coefficients: 5	Combustion	4	2	1h30	1h30		45:00	55:00	40%	60%
	Gas dynamics	4	2	1h30	1h30		45:00	55:00	40%	60%
	Thermal drying	2	1	1h30			10:30 p.m.	27:30		100%
Fundamental EU Code: UEF 1.2.2 Credits: 8 Coefficients: 4	Heating and air conditioning	4	2	1h30	1h30		45:00	55:00	40%	60%
	In-depth turbomachinery	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 1.2 Credits: 9 Coefficients: 5	Finite volume methods	6	3	1h30		3:00 a.m.	67h30	82h30	40%	60%
	Servicing and regulation	3	2	1h30		1h00	37:30	37:30	40%	60%
EU Discovery Code: UED 1.2 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
Transversal EU Code: UET 1.2 Credits: 1 Coefficients: 1	Compliance with standards and rules of ethics and integrity	1	1	1h30			10:30 p.m.	02:30		100%
Total semester 2		**30**	**17**	**3:00 p.m.**	**6:00 a.m.**	**4:00 a.m.**	**375h00**	**375h00**		

Semester 3

Teaching unit	Materials Titled	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method	
				Course	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 2.1.1 Credits: 8 Coefficients: 4	Internal combustion engines in depth	4	2	1h30	1h30		45:00	55:00	40%	60%
	Cryogenics	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 2.1.2 Credits: 10 Coefficients: 5	Propulsion mechanics	6	3	3:00 a.m.	1h30		67h30	82h30	40%	60%
	Heat exchangers	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 2.1 Credits: 9 Coefficients: 5	CFDs and software	4	2			3:00 a.m.	45:00	55:00	100%	
	Optimization	3	2	1h30		1h00	37:30	37:30	40%	60%
	TP Heat exchangers	2	1			1h30	10:30 p.m.	27:30	100%	
EU Discovery Code: UED 2.1 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
	Material of your choice	1	1	1h30			10:30 p.m.	02:30		100%
Transversal EU Code: UET 2.1 Credits: 1 Coefficients: 1	Documentary research and dissertation design	1	1	1h30			10:30 p.m.	02:30		100%
Total semester 3		**30**	**17**	**1:30 p.m.**	**6:00 a.m.**	**5:30 a.m.**	**375h00**	**375h00**		

Discovery Unit (S1, S2 and S3)

1- *Energy transport and storage*
2- *Applied electronics*
3- *Applied electrical engineering*
4- *Energetic audience*
5- *Renewable energies*
6- *Maintenance andIndustrial Security*
7- *Health and Safety*
8- *Aeronautics*
9- *Transportation*
10- *Reliability*
11- *quality management*
12- *Collaborative Design*
13- *Theory of solving innovation problems "TRIZ Method"*
14- *Hydraulic and pneumatic systems and devices*

Semester 4

This semester is devoted to carrying out the end of the master's cycle project. It is carried out in a company or in a research laboratory (university or research center). It is sanctioned by a dissertation and a defense.

	VHS	coefficient	Credits
Personal work	550	09	18
Internship in companyor in a laboratory	100	04	06
Seminars	50	02	03
Other (Framing)	50	02	03
Total Semester 4	750	17	30

This table is given for information purposes only.

Evaluation of the End of Master Cycle Project

- Scientific values (jury assessment) /6
- Writing of the dissertation (jury assessment) /4
- Presentation and response to questions (Jury assessment) /4
- Appreciation of the supervisor /3
- Presentation of the internship report (Jury assessment) /3

III - Detailed program by subject for the S1 semester

Semester:1
Teaching unit: UEF 1.1.1
Subject: In-depth fluid mechanics
VHS: 45 hours (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The aim of the subject is to develop the student's basic knowledge. The energy specialty is closely linked to the phenomenology of viscous and turbulent flows observed in energy systems, their understanding and analysis are essential. Impregnating the student with the physical and mathematical laws and models of these often complex flows is one of the fundamentals of the specialty in the acquisition of consistent teaching necessary for research.

Recommended prior knowledge:

Basics of fluid mechanics, Basics of mathematics.

Content of the material:

Chapter 1: Introduction **(1 week)**

Fundamental principles and theorems of fluid statics and kinematics. Concept on potential flows.

Chapter 2: Dynamics of viscous flows **(6 weeks)**

Viscous fluids. Description of viscous friction. Strain rate and stress tensors and their connection. Naviers-Stokes equation. Applications to laminar flows (Poiseuille, Couette).

Chapter 3: Applications of the Navier-Stokes equations**(2 weeks)**

Limiting cases of viscosity. Flow at low Reynolds number: Hydrodynamic lubrication, movement along a sphere, movement along a cylinder.

Chapter 4: Laminar boundary layers **(6 weeks)**

CLL equations. Characteristic parameters of the CLL (Thicknesses of displacement and momentum, Form factor). Exact solutions of the CLL (case of the flat plate). Von-Karman integral equation. Analysis of CLL by the Karman-Pohlhausen method. Stability of CLL.

Chapter 5: Notions on turbulent flows **(1 week)**

Fluctuations in the velocity vector. Average movement. Turbulence modeling. Turbulence models.

Evaluation method:

ControlContinuous :40%,Exam :60%.

Bibliographic references:

1- *Inge L. Ryhming, Fluid dynamics, Presse Polytechniques et Universitaire Romandes.*
2- *P. Chassaing, Turbulence in fluid mechanics, CEPADUES – Editions*
3- *R. Comolet, Experimental fluid mechanics, Volume II, dynamics of real fluids, turbomachines, Editions Masson, 1982.*
4- *TC Papanastasiou, GC Georgiou and AN Alexandrou, Viscous fluid flow, CRC Press LLC, 2000.*

5- *Adil Ridha, Real fluid dynamics course, M1 Mathematics and applications: Mechanics specialty, University of Caen, 2009.*
6- *RW Fox, AT Mc Donald and PJ Pritchard, Introduction to fluid mechanics, sixth edition, Wiley and sons editor, 2003*
7- *Hermann Schlichting, Boundary layer theory, McGraw Hill book Company.*
8- *WP Graebel, Advanced fluid mechanics, Academic Press 2007.*

Semester: 1
Teaching unit:UEF 1.1.1
Subject: Thermal machines
HVS: 45h (Race: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
This teaching contributes to the acquisition of essential knowledge for energy master's students. Students will obtain the fundamentals to understand and analyze the operation of different types of thermal machines

Recommended prior knowledge: Thermodynamics

Matter Content:

Chapter 1: Reminder of technical thermodynamics (2 weeks)
- Concepts of state variables, equations of state of ideal gases
- First law of thermodynamics
- Second law of thermodynamics

Chapter 2: Receiver cycle machines (3 weeks)
- Compressors (alternative compressors: single-stage and multi-stage compression, efficiencies)
- Refrigerating machines
- Heat pump

Chapter 3: Ideal Cycles of Internal Combustion Engines (3 weeks)
- Spark ignition cycle
- Diesel cycle
- Mixed cycle

Chapter 4: Gas turbine and turbojet (3weeks)
- Basic cycle,
- Other cycles,
- Performance criteria and yields

Chapter 5: Steam turbine (3weeks)
- Rankine cycle without and with overheating
- Hirn cycle
- Racking cycles

Chapter 6: Other types of engines (2weeks)
- Stirling engines
- Ericsson engine
- Engine compressed air

Evaluation method:
Continuous Control: 40%, Exam: 60%.

Bibliographic references:

1. *Technical thermodynamics, volumes 1,2 and 3, Maurice Bailly-Bordas Paris –Montreal 1971.*
2. *Thermal machines,EmilianKoller, Dunod technical and engineering collection, 2005.*
3. *Thermodynamics of fluid systems and thermal machines: Principles, models and applications, FOHR Jean-Paul, Lavoisier 2010.*

Semester: 1

Teaching unit: UEF1.1.2
Matter :Deep heat and mass transfer
VHS: 67h00 (Class: 3h00, Tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
- Master the basic notions of the three modes of heat transfer;
- Know how to write a report and build an elementary model.

Recommended prior knowledge:
- Training in mathematics and physics or mechanics;
- Knowledge of applied thermodynamics.

Content of the material:

Chapter 1: Heat conduction (4 weeks)
1. Two-dimensional heat conduction in steady state, Analytical methods, Method of separation of variables, Conduction form factor. Graphical method, Numerical methods (finite differences).
2. Heat conduction in transient conditions: Lumped Capacitance Model (LCM Method), Range of validity.
   One-dimensional transient solutions: Use Fourier analysis and Laplace transformation.

Chapter 2: Heat convection (5 weeks)
1. Natural convection :
   Natural convection on a vertical flat plate. Physical mechanisms, equations of the boundary layer in the laminar regime, Study of similarity, Transition to the turbulent regime. Natural convection in a rectangular cavity.
2. Forced convection:
   Hydrodynamic and thermal boundary layers, Integral methods. Convection equations, Modeling of a convection problem.
   Solutions to some convection problems. Forced convection in a cylinder.
3. Thermal transfers during phase changes:
   Boiling of pure substances, Main physical quantities occurring during boiling. Mud boiling and convective boiling. Boiling diets. Evaluation of the heat exchange coefficient and inherent errors.
   Types of condensation. Condensation in drops and condensation in films. Film condensation on a vertical flat plate and on a horizontal cylinder, Nusselt theory. Liquid film flow regimes. Practical use of correlations.

Chapter 3: Heat transfer by radiation (3 weeks)
1. Beer's law. Radiative properties of gases (SEM Semi-Transparent Media). Radiative properties of particles. Establishment of the Radiative Transfer Equation (REE).
2. Some approximate solutions of the simplified ETR.

Chapter 4: Mass transfer (3 weeks)
1. Mass transfer by diffusion: Mechanisms of mass diffusion. Composition of the mixture. Fick's law, mass diffusivity.

2. Mass transfer by convection: Mass boundary layer. Convective mass flow. Dimensionless numbers and thicknesses of boundary layers (mass, hydrodynamic, thermal). Conjugated transfer of heat and mass.

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

Bibliographic references:

1. *HS Carslaw, Introduction to the mathematical theory of the conduction of heat in solids, Mc Millan and Co ed., 1921, 2nd edition.*
2. *HS Carslaw and JC Jaeger, Conduction of heat in solids, 2nd edition, Clarendon press ed., 1959.*
3. *Latif Jiji, Heat Conduction, Jaico Publishing House, 2003.*
4. *Ozisik, M.N., 1980, Conduction Heat Transfer, John Wiley and Sons, New York.*
5. *Gebhart, Heat transfer, McGraw Hill editor, 1971*

A. *B. De Vriendt, The transmission of heat, Volume 2, Introduction to thermal radiation, Gaetan Morin, 1983.*

6. *Bejan, AD Kraus, Heat transfer handbook, John Wiley Editor, 2003.*
7. *Vedat S. Arpaci, Conduction Heat transfer, 1966 by Addison-Wesley publishing.*
8. *R. Ghez, A Primer of Diffusion, John Wiley and Sons Editor, 1988, 2nd edition.*
9. *Chandrasekhar, radiative transfer, Dover publication, 1960.*
10. *MF Modest, Radiative heat transfer, Academic Press, 3rd edition, 2012*
11. *M. Quinn Brewster, Thermal radiative transfer and properties, Wiley Inter-science Publication, 1992*
12. *Hottel, H. C, and A. F. Sarofim, Radiative Transfer, McGraw-Hill, New York, 1967*
13. *R. Siegel and JR Howell, Thermal Radiation Heat Transfer, 5th Edition, Ed. Taylor and Francis, 2010.*
14. *M. NecatiOsizik, Radiative transfer and interactions with conduction and convection, Ed. J. Wiley and Sons*
15. *RB Bird, WE Stewart, EN Lightfoot, Transport phenomena, Wiley editor, 1960.*
16. *Rjucsh K. Kundu, IM Cohen, Fluid Mechanics, 2nd Edition, Academic Press, 2002.*
17. *DP Kesseler and RA Greenkorn, Momentum, Heat, and Mass transfer: Fundamentals, M. Dekker, 1999.*
18. *Kreith, F.; Boehm, RF et al., Heat and Mass Transfer, Mechanical Engineering Handbook Ed. Frank Kreith, CRC Press LLC, 1999.*
19. *HD Baehr and K. Stephan, Heat and Mass transfer, 2nd revised edition, Springer Verlag editor, 2006.*
20. Yunus A. Çengel, Afshin J. Ghajar:Heat and Mass Transfer, Fundamentals and Applications, McGraw-Hill, 2015.
21. Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine: fundamentals of heat and mass transfer, John Wiley and Sons, 2006.

Semester: 1
Teaching unit :UEF 1.1.2
Matter :In-depth numerical methods
VHS: 45 hours (Class: 1:30 a.m., tutorial: 1:30 a.m.)
Credits: 4
Semester: 2

Teaching objectives:
Learn new digital techniques to solve the different equations appearing in energy (fluid mechanics, thermal, etc.). Emphasis will be placed on solving differential and partial differential equations

Recommended prior knowledge:
It is recommended to master numerical, mathematical analysis (EDP).

Content of the material:
Chapter 1:**Concepts on partial differential equations** **(1 weeks)**
Modeling concepts. Classification of PDEs. Linear and nonlinear PDEs. Different types of boundary conditions.

Chapter 2:**Analytical methods** **(2 weeks)**
Principle of superposition. Variable separation method. Application to the diffusion equation with Dirichlet condition, to the Laplace equation in Cartesian coordinates and to the wave equation.

Chapter 3: Finite difference methods **(6 weeks)**
Introduction to numerical methods. Principle of MDF. Discretization schemes. Stability, consistency and convergence. Discretization methods (explicit, implicit, Crank-Nicholson). Application to the diffusion equation. Matrix formulation. 2nd type boundary conditions. Nonlinear equations. Multidimensional problems.

Chapter 4: Laplace equation **(5 weeks)**
5 point wording. Variable Dirichlet conditions. Resolution methods. Neumann condition. Poisson equation. 9 point formation. Non-rectangular domain. Nonlinear equations and three-dimensional problems.

Chapter 5: Wave equation **(1 weeks)**
Discretization and stability. Different discretization schemes (Euler, Upwind, Lax, Leapfrog). Resolution methods.

Evaluation method:
ControlContinuous :40%,Exam :60%.

Bibliographic references:

1. *F. Jedrzejewski, Introduction to numerical methods, Second edition, Springer-Verlag, France, Paris 2005.*
2. *WH Press, S. Teukolsky, WT Vetterling, BP Flannery, Numerical recipes in FORTRAN, Cambridge University press, 1995.*
3. *B. Carnahan, HA Luther and JO Wilkes, Applied numerical methods, R. Kriegerpublisher, 1990.*
4. *FS Acton, Numerical methods that work, the mathematical association of America, 1990.*
5. *Joe D. Hoffman, Numerical Methods for Engineers and Scientists 2nd Edition, Marcel Dekker, editor, 2001.*

6. *N. Boumahrat and Gourdin, Numerical methods, OPU, 1980.*
7. *JD Faires and RL Burden, Numerical methods, Brooks Cole 3rd edition, 2002*
8. *Oliver Aberth, Introduction to Precise Numerical Methods, Elsevier editor, 2007.*
9. *Rao V. Dukkipati, Numerical methods, Publishing for one world, 2010*
10. *MN Ozisik, "Finite Difference Methods in Heat Transfer"; Mechanical and Aerospace Engineering Department North Carolina State University*
11. *HK Versteeget W. Malalasekera, An introduction to computational fluid dynamics. The Finite volume method, Longman scientific & technical, London, 1995.*
12. *Zienkiewic, Numerical methods in heat transfer, McGraw Hill editor, 1988.*
13. *JC Tannehill, DA Anderson and RH Plercher, Computational Fluid Mechanics and Heat Transfer, second edition, Taylor and Francis editor, 1997.*
14. *H. Lomax, TH Pulliam and David W. Zingg, Fundamentals of Computational FluidDynamics, 1999*
15. *SV Patankar, Numerical heat transfer and fluid flow, McGrawHill, Hemisphere, Washington, DC, 1980.*
16. *HK Versteeget W. Malalasekera, An introduction to computational fluid dynamics. The Finite volume method, Longman scientific & technical, London, 1995.*

Semester: 1
Teaching unit: UEM 1.1
Matter :Instrumentation and measurements
VHS: 45h (Class: 1h30, TP: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The student will learn the principles of Instrumentation and Regulation (Metrology Process Control, Physical quantities, passive, active, integrated sensor, Characteristics, Transmitter and standards and Functional diagram.

Practical work (depending on the technical capabilities of the establishment)

Recommended prior knowledge:

General mechanics, electricity,Basic elements of electronics.

Content of the material:

Chapter 1: Introduction **(1 week)**

Chapter 2: Thermal measurement methods and techniques **(4 weeks)**
- Temperature measurement
- Pressure measurement
- Flow measurement

Chapter 3: Calibration **(3 weeks)**
- Calibration of a thermocouple
- Calibration of a pressure sensor
- Calibration of a flow meter

Chapter 4: Data processing **(3 weeks)**
- Concept of random variable
- Data acquisition system
- Calculation of errors and uncertainties
- Descriptive statistics

Chapter 5: Introduction to experimental designs **(4 weeks)**
- Terminology
- Study of a case (Complete Factorial Plan)

Evaluation method:

Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1. *"Physical measurements and instrumentation: Statistical and spectral analysis of measurements, sensors", Barchiesi, Dominique, Paris, Ellipse, 2003.*
2. *"Sensors in industrial instrumentation", Asch, Georges, Paris, Dunod, 1999.*
3. RJ Goldstein, "Fluid Mechanics Measurements", 1983.

Semester: 1
Teaching unit: UEM 1.1
Matter :TPNumerical methods
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

The student will have the necessary skills to numerically model physical phenomena in the field of energetics. The modeling is based on numerical discretization methods for a better understanding of fluid flow phenomena coupled with heat and mass transfers.

Recommended prior knowledge:

Numerical method courses, digital analysis, programming.

Content of the material:

1. **Analytical resolution** **(3 weeks)**
   - 1D heat equation
   - 2D Laplace equation
2. **Numerical solution of the Poisson equation** **(4 weeks)**
   - Explicit schema
   - Implicit schema
   - Crank–Nicholson scheme
3. **Numerical solution of the Laplace equation** **(4 weeks)**
   - Dirichlet conditions
   - Neumann conditions
4. **Numerical solution of the wave propagation equation** **(4 weeks)**

Evaluation method:

ControlContinuous: 100%.

Bibliographic references:

1. *John D. Anderson, JR. Computational Fluid Dynamics the Basics With Applications, (1995).*
2. *T.CebeciJ.RShao F. Kafyeke E. Laurendeau. Computational Fluid Dynamics for Engineers. (2000).*
3. *Suhas V Patankar. Numerical Heat Transfer and Fluid Flow. (1980).*
4. *Ferziger&Peric. Computational Methods for Fluid Dynamics.*
5. *Randall J. Leveque. Finite Volume Methods for Hyperbolic Problems,*
6. *E.Toro. Riemann solvers and numerical methods for fluid dynamics, Springer, Berlin (1999).*
7. *https://www-n.oca.eu/pichon/IDRIS_Fortran_cours.pdf*
8. *http://www.idris.fr/formations/mpi/*
9. *Fluent 5.4.8 Copyright 1999 Fluent Inc.*

Semester: 1
Teaching unit: UEM 1.1
Subject: Thermal machines P.W.
VHS:10:30 p.m. (P.W.: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Students will acquire fundamentals to practically understand and analyze the operation of various types of thermal machines.

Recommended prerequisite knowledge:
Material and Energy Balances, Thermodynamics, Thermal Machines.

Subject content: Topics vary based on available resources:

1. Hydraulic Turbines and Pumps;
2. Steam Turbines and Thermal Power Plants;
3. Gas Turbines and Turbomachinery;
4. External Combustion Engines: Stirling Engine;
5. Internal Combustion Engines;
6. Heat Pumps;
7. Refrigeration Machinery;
8. Single-phase Heat Exchangers;
9. Steam Generators;
10. Exergetic analysis.

Assessment method:
Continuous Assessment: 100%.

Bibliographic references:

Semester: 1
Teaching unit: UEM 1.1
Matter :TP MDF
VHS: 3:00 p.m. (TP: 1:00 a.m.)
Credits: 1
Coefficient: 1

Teaching objectives:
The Fluid Mechanics Lab Module plays a fundamental and active role in enabling students to gain cognitive understanding and empirical information in the field of fluid mechanics. This module is carried out in the form of a series of experiments which serve to help our students to better understand the fluid mechanics that they have done theoretically during the past semester and to consolidate the theoretical knowledge acquired in the fluid mechanics course.

Recommended prior knowledge:

Fluid mechanics, thermodynamics course.

Content of the material:depending on existing equipment

Practically illustrate the knowledge acquired in the Fluid Mechanics course.

TP No. 1: Flowmeters in load flows (The venturi & the diaphragm);
TP No. 2: Flow through an orifice;
TP No. 3: Experience of the impact of a jet of water on different obstacles;
TP No. 4: Reynolds experiment: laminar and turbulent flows;
TP No. 5: Flow around an obstacle;
TP No. 6: Measurements of singular pressure losses in a pipe and speed profiles.
Other practical work to be offered depending on the material available.

Evaluation method:
ControlContinuous: 100%.

Bibliographic references:

1. *Existing books and handouts in the teaching and research laboratories (Thermal Laboratory, MDF Laboratory, Aerodynamic Laboratory, Departmental Research Laboratory) and the department's libraries.*
2. *http://www.tecquipment.com/Thermodynamics/Heat_Transfer.aspx?page=1*
3. *http://www.deltalab-smt.com/teaching-energetics/heat-exchanges*
4. *Websites.*

Semester: 1
Teaching unit: UED 1.1
Matter :Subject 1 of your choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 1
Teaching unit: UED 1.1
Matter :Subject 2 of your choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 1
Teaching unit: UET 1.1
Matter :Technical English and terminology
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Introduce the student to technical vocabulary. Strengthen your knowledge of the language. Help him atunderstand and synthesize a technical document. Allow him to understand a conversation in English held in a scientific framework.

Recommended prior knowledge:
Basic English vocabulary and grammar.

Material content:

- Written comprehension :Reading and analysis of texts relating to the specialty.
- Oral comprehension: Using authentic popular science video documents,note taking, summary and presentation of the document.
- Oral expression: Presentation of a scientific or technical subject,development and exchange of oral messages (ideas and data), Telephone communication, Gestural expression.
- Written expression :Extraction of ideas from a scientific document, Writing a scientific message, Exchange of information in writing,writing CVs, application letters for internships or jobs.

Recommendation :It is strongly recommended that the person responsible for the subject presents and explains at the end of each session (at most) around ten technical words of the specialty in the three languages (if possible) English, French and Arabic.

Evaluation method:
Review: 100%.

Bibliographic references:

1. *PT Danison, Practical guide to writing in English: uses and rules, practical advice, Editions d'Organization 2007.*
2. *A.Chamberlain, R. Steele, Practical guide to communication: English, Didier 1992.*
3. *R. Ernst, Dictionary of applied techniques and sciences: French-English, Dunod 2002.*
4. *J. Comfort, S. Hick, and A. Savage, Basic Technical English, Oxford University Press, 1980.*
5. *EH Glendinning and N. Glendinning, Oxford English for Electrical and Mechanical Engineering, Oxford University Press 1995.*
6. *TN Huckin, and AL Olsen, Technical writing and professional communication for non-native speakers of English, McGraw-Hill 1991.*
7. *J. Orasanu, Reading Comprehension from Research to Practice, Erlbaum Associates 1986.*

IV - Detailed program by subject for the S2 semester

Semester:2
Teaching unit: UEF 1.2.1
Subject:Combustion
HVS: 45h00 (Race: 1:30 a.m., TD: 1:30 a.m.)
Credits: 4
Coefficient: 2

Teaching objectives:
Introducing students to the field of combustion, the student will learn to calculate the properties of gas mixtures, the calorific values of hydrocarbons as well as the adiabatic temperature of flames. Also, concepts on chemical equilibrium, chemical kinetics and the different types of flames.

.

Recommended prior knowledge:
Thermodynamics (first law and enthalpy, second law and entropy).

Matter Content:

Chapter 1: Reminders and fundamental concepts of combustion (3 weeks)

1.1 Types of fuels and combustibles: solid, liquid and gaseous, physical and chemical properties, octane number, cetane number.
1.2 Reaction enthalpy and sensitive enthalpies.
1.3 Gas mixtures, Stoichiometry, richness and excess air coefficient.
1.4 Combustion reactions.
1.5 Calorific value: Calculation of Pci and Pcs

Chapter 2: Thermochemistry (3 weeks)

2.1 Adiabatic flame temperature at constant volume and constant pressure.
2.3 Calculation of the temperature of a combustion chamber.
2.4 Equilibrium constants and reaction rates.
2.5 Kinetics of combustion.

Chapter 3: Reactive flow equations (2 weeks)

3.1 Conservation of mass, momentum, energy and chemical species.
3.3 Chemical and thermal production.

Chapter 4: Laminar flames of premixing and diffusion (3 weeks)

4.1 Definition of premixing flames and application examples.
4.2 Structure and speed of premixing flames.
4.3 Theory and kinetics of laminar premixing flames.
4.5 Definition of diffusion flames and application examples.
4.6 Structure of diffusion flames.
4.7 Mathematical formulation for laminar flames.

Chapter 5: Turbulent flames (**4**weeks)

6.1 Self-ignition and propagation..
6.2 Turbulent premixING flames.
6.3 Some models of premixed combustion.
6.4 Turbulent diffusion flames.
6.5 Some models of non-premixed combustion.
6.6 Combustion regimes and turbulent combustion diagrams.

Evaluation method:

Continuous control:40%,Test:60%.

Bibliographic references:

1. *Stephen Turns, An Introduction to Combustion: Concepts and Applications 3rd Edition ISBN-13: 978-0073380193.*
2. *Kenneth Kuan-yunKuo, Principles of Combustion 2nd Edition ISBN-13: 978-0471046899.*
3. *Warnatz J, Maas U, Dibble RW. Combustion. 3rd ed. Springer Berlin Heidelberg New York; 2006.*
4. *El Mahallawi F, El Din Habik S, Fundamentals and Technology of combustion, Elsevier 2002, ISBN-0-08-044 108-8.*

Semester: 2
Teaching unit: UEF 1.2.1
Matter :Gas dynamics
VHS: 45h00 (class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Gas dynamics is a very broad field whose theoretical objective is the study of compressible flows at high speeds. These types of flows are most often encountered in the practical field of the aeronautical and space industry. This module only deals with the one-dimensional approach to compressible ideal gas flows.

Recommended prior knowledge:

Thermodynamics and fluid mechanics.

Content of the material:

Chapter 1: Introduction to Gasodynamics (1 week)

1. Thermodynamic concepts and relationships.
2. Isentropic relations of an ideal gas.
3. Compressibility and propagation of sound waves.
4. General expression for the speed of sound.
5. Mach number and Mach waves.
6. Subsonic, transonic, supersonic and hypersonic flows.

Chapter 2: 1D Isentropic Flow in Variable Section Conduit (5 weeks)

1. Basic equations (continuity, momentum, energy).
2. General laws of isentropic flow: generating state and critical state.
3. 1D flow in a pipe of variable section and Hugoniot's theorem.
4. Study of a flow in a nozzle: convergent and convergent-divergent.
5. Overview of subsonic and supersonic diffusers.

Chapter 3: Shockwaves (4 weeks)

I- Normal Shock Waves

1. Basic equations (continuity, momentum, energy) and Prandtl relation.
2. Relations of the normal shock wave as a function of the mach number.
3. Borderline cases: weak shock waves, strong shock waves.
4. The moving normal shock wave.
5. Pitot tube in supersonic.

II. Oblique Shock Waves

1. Concept on oblique shock waves.
2. Basic equations and Prandtl relation.
3. Reflection of oblique waves.

Chapter 4:Prandtl–Meyer relaxation (2 weeks)

Chapter 5: 1D Non-Isentropic Flow in Constant Section Conduit (3 weeks)

I. Adiabatic flow with friction: Fanno flow

1. Fanno flow analysis and basic equations.
2. Variation of flow characteristics as a function of Mach number.
3. Friction coefficient and entropy variation.
4. Shock wave in the Fanno flow.

II. Frictionless flow with heat exchange: Rayleigh flow

1. Rayleigh flow analysis and basic equations.
2. Variation of flow characteristics as a function of Mach number.
3. Entropy variation.

III. Flow with friction and with heat exchange

Evaluation method:

Continuous monitoring :40%,**Exam :**60%.

Bibliographic references:

1- *Patrick Chassaing. Fluid Mechanics, 3rd edition, Cépaduès, Toulouse, 2010. André Lallemand. One-dimensional flow of compressible fluids, Engineering techniques Energy engineering, B- 8- 165.*

2- *FM White. Fluid Mechanics, 5th edition, McGraw-Hill, New York, 2003.*

3- *RW Fox and AT McDonald. Introduction to Fluid Mechanics, 5th edition, New York: Wiley, 1999.*

4- *JD Anderson. Modern Compressible Flow with Historical Perspective, 3rd edition, New York: McGraw-Hill, 2003.*

5- *H. Liepmann and A. Roshko. Elements of Gas Dynamics, Dover Publications, Mineola, NY, 2001.*

6- *Genick Bar–Meir, Fundamentals of Compressible Fluid Mechanics, Minneapolis, MN 55414-2411, 2009.*

7- *Robert d. Zucker, Oscar Biblarz, Fundamentals Of Gas Dynamics, JOHN WILEY & SONS, 2002.*

8- *Patrick Oosthuizen, William Carrascallen, Compressible Fluid Flow, McGraw-Hill, 1997.*

9- *Klaus Hoffmann, Computational Fluid Dynamics, Volume II, EES, 4th edition, 2000.*

Semester: 2
Teaching unit:UEF 1.2.1
Subject: Thermal drying
VHS: 10:30 p.m. (Race: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:
The aim of the matter is to present the theoretical principles of thermal drying, including mechanisms, mass and heat transfer equations, drying curves and humid air diagrams. Thermal drying techniques are linked to thermodynamic laws and the principles of mass and heat transfer, which allows the student to apply their prerequisite knowledge to solve drying problems in different sectors: Agri-food, textiles, paper and building materials,...

Recommended prerequisite knowledge:
Thermodynamics, Mass and heat transfer

Matter content:

Chapter 1: Reminders on humid air **(2 weeks)**
Absolute humidity, relative humidity, dry temperature, wet temperature, dew point, enthalpy, humid air mixture, humid air diagram.

Chapter 2: Drying theory **(3 weeks)**
Drying terminology, Mechanisms involved during thermal drying.

Chapter 3: Dryer calculation principles **(5 weeks)**
Method of determining calculation parameters, Calculation and sizing of a conveyor belt dryer, a pneumatic dryer, a rotary dryer and in a fluidized bed dryer.

Chapter 4: Drying equipment and processes **(5 weeks)**
Drying of solid products, pasty products, liquid products, Definition of a dryer, Additional devices necessary for the operation of a dryer.

Evaluation method:
Test:100%.

Bibliographic references:

1. *Mujumdar AS, Handbook of industrial drying, Marcel Dekker, New York, 1987.*
2. *Nadeau J.-P., Puiggali J.-R., Drying: from physical processes to industrial processes, 307p., Tec et Doc, Paris, 1995.*
3. *Catherine BONAZZI, Jean-Jacques BIMBENET, Drying of food products - Principles, Engineering techniques, f3000, 2003.*
4. *Catherine BONAZZI, Jean-Jacques BIMBENET, Drying of food products - Devices and applications, Engineering techniques, f3002, 2008.*
5. *Jean VASSEUR, Industrial drying: principles and calculation of devices - Other drying methods than hot air, part 1, Engineering techniques, Engineering techniques, j2453, 2011.*
6. *Jean VASSEUR, Industrial drying: principles and calculation of devices - Convective drying by hot air (part 2), Engineering techniques, j2452, 2010.*

7. *André CHARREAU, Roland CAVAILLÉ, Drying. Theory and calculations, Engineering Techniques, j2480, 1995.*

Semester: 2
Teaching unit :UEF 1.2.2
Matter :Heating and air conditioning
VHS: 45h (lesson: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
The content of this subject provides students with the concepts and tools necessary for sizing heating and air conditioning installations.

Recommended prior knowledge:
Thermodynamics, heat transfer, fluid mechanics.

Content of the material:

Chapter 1. Reminder of thermodynamics and heat transfer (1 week)
- General notions of thermodynamics
- Thermal transfer modes

Chapter 2: Building thermal (2 weeks)
- Algerian thermal regulations (DTR documents)
- Thermal requirements
- Thermal insulation

Chapter 3: General principles of heating (5 weeks)
- Calculation of heat losses
- Heat production
- Distribution and broadcast

Chapter 4: General principles in air conditioning (5 weeks)
- Calculation of heat inputs
- Air conditioning systems and distribution networks
- Humid air and hx diagram
- Cold production

Chapter 5: Systems regulation (1 week)

Chapter 6: Renewable energy equipment (1 week)

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

Bibliographic references:

1. Treatise on heating and air conditioning, H. Rietschel and W. Raiss, Dunod 1993.
2. Heating practice, J. Bossard and J. Hrabovsky, Dunod 2014.

Semester: 2
Teaching unit: UEF 1.2.2
Matter :In-depth turbomachinery
VHS: 45h00 (class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Describe, from basic notions (turbomachines and fluid mechanics) the methods of design, analysis and construction of turbomachines to enable students tounderstanding of the flows that are established in turbomachines and to develop basic elements for the design and selection of these machines.

Recommended prior knowledge:
Thermodynamics, heat transfer, fluid mechanics, Turbomachines.

Content of the material:

Chapter 1. **(3 weeks)**
Reminder on turbomachines, classification, notion of similarity, dimensionless numbers and velocity triangles, Eulerdes equation for turbomachines

Chapter 2.Aerodynamics of blade grilles **(3 weeks)**
- 2.1 Aerodynamic forces (lift and drag)
- 2.2Correlations for the design of blade grids (solidity, deviation, deflection, etc.)

Chapter3. 2D flow in turbomachines **(4 weeks)**
- 3.1 Simplified radial balance equation
- 3.2 Theory of actuator disks
- 3.3 Vane-to-vane flow
- 3.4 Boundary layers and concept of transition

Chapter4.3D flow in turbomachines **(3 weeks)**
- 4.1 Governing equations
- 4.2 CFD for turbomachines (applications and limitations)
- 4.3 In-stationary flow and Stator-Rotor interaction
- 4.4 Cooling of turbomachines
- 4.5 Losses in turbomachines (of profiles, due to secondary flows, clearance, etc.).
- 4.6Measurement techniques in turbomachines

Chapter 5. Construction of turbomachines **(2 weeks)**
- 5.1 Turbomachinery components: bearings, couplings, reduction gears, lubrication and sealing systems
- 5.2 Construction of steam turbines: nozzles, blades, single stage efficiency, body and diaphragm, rotor, material, balancing, valves and steam inlet valves, speed regulation
- 5.3 Gas turbines: compressor, combustion chamber, turbine, fuels
- 5.4 Compressors: centrifugal, axial, reciprocating, use.

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

Bibliographic references:

1. *SLDixonFluid Mechanics, Thermodynamics of Turbomachinery, 5th ed., Elsevier Butterworth.*
2. *Heinemann, 2005.*
3. *HIH Saravanamuttoo, GFCRogers, H. Cohen, and PV Straznicky, Gas Turbine Theory, 6th ed.*
4. *Pearson Education, London, 2008.*
5. *B. Lakshminarayana, Fluid Dynamics and Heat Transfer of Turbomachinery, Wiley, New York, 1996.*
6. *JC Han, S. Dutta, S. Ekkad, Gas Turbine Heat Transfer And Cooling Technology, Taylor & Francis 2000.*

Semester: 2
Teaching unit: UEM 1.2
Matter :Finite volume method
VHS: 45h00 (Class: 1h30, TP: 3h00)
Credits:6
Coefficient: 3

Teaching objectives:
Learn numerical techniques to solve the different governing equations of fluid mechanics and heat transfer. Emphasis will be placed on solving conservation equations. This subject also allows the student to have developed the ability to understand and program the finite volume method for fluid flow phenomena coupled to heat and mass transfers and to be able to judiciously use the CFD software which is essential for calculating industrial problems.

Recommended prior knowledge:
It is recommended to master numerical, mathematical analysis (EDP).

Content of the material:
Chapter 1 : General information on computational fluid dynamics (CFD) **(1 week)**

Chapter 2 : Conservation principle (2 weeks)
- Mass conservation equation.
- Momentum conservation equation.

Chapter 3: Finite volume method for diffusion problems **(6 weeks)**
1- One-dimensional diffusion problem
   - 1D diffusion equation.
   - 1D diffusion equation with source term.
2- Two-dimensional diffusion problem
   - 2D stationary diffusion equation without source term.
   - 2D stationary diffusion equation with source term.
3- Three-dimensional diffusion problem.

Chapter 4: Finite volume method for convection-diffusion problems
(6 weeks)
1- Stationary 1D convection-diffusion equation
   - Centered diagram
   - Off-center pattern (Upwind)
   - Exponential scheme
   - Hybrid Scheme
   - Power Law Diagram
2- Unsteady 1D diffusion equation
   - Explicit schema
   - Implicit schema
   - Crank–Nicholson scheme

Organization of practical work:
1- **Digital resolution by MVF of diffusion problems**.
   - One-dimensional diffusion problem.
   - Two-dimensional diffusion problem.

2- **Numerical resolution by MVF of convection-diffusion problems.**
  - Stationary 1D convection-diffusion equation: Centered scheme, Off-center scheme (Upwind), Exponential scheme, Hybrid scheme, Power Law scheme.
  - Unsteady 1D diffusion equation: Explicit scheme, Implicit scheme, Crank-Nicholson scheme.

Evaluation method:

Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1. HK Versteeg, W. Malasasekera, "Introduction to ComputationalFluid Dynamics: The finite volume method (2nd Edition)", Pearson, Prentice Hall, 2007.
2. *S.V.Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere, Washington, DC, 1980*.

Semester: 2
Teaching unit: UEM 1.2
Matter :TP Turbomachines
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Put into practice the basic notions (of turbomachines and fluid mechanics) methods of design, analysis and construction of turbomachines to enable students tounderstanding of the flows that are established in turbomachines and to develop basic elements for the design and selection of these machines.

Recommended prior knowledge:

Turbomachinery courses

Content of the material:

Do some turbomachinery practical work depending on the equipment available, use of simulation software.

Evaluation method:

Continuous Control: 100%.

Bibliographic references:

Semester: 2
Teaching unit: UEM 1.2
Matter :Servicing and regulation
VHS: 37h30 (Class: 1h30, TP: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:
The aim of teaching students the basic principles of control is to constantly measure the difference between the real value of the quantity to be controlled and the set value that we wish to achieve, and to calculate the appropriate command to apply to one (or more)actuator(s) so as to reduce this gap as quickly as possible.

Recommended prior knowledge:
Digital methods, computing, electricity…

Content of the material:

Chapter 1: Introduction to servos (2 weeks)
Concepts on analog servos. Structure diagram.
Representation of a control system. Functional diagram of a slave system. BO and BF control. Transfer function. transfer function of elementary systems. exercises

Chapter 2: Performance of a linear servo system (2 weeks)
Concept of regime, Evaluation of the performances of a controlled system, static and dynamic precision, study of some elementary systems, Performances, Exercises**.**

Chapter 3: Analysis of linear servos (2 weeks)
Frequency responses and Bode curves, Nyquist representation: Frequency response of a system in LF, Black diagram (Black Nichols), Exercises

Chapter 4: Stability of Linear servos (3 weeks)
Methods for studying stability, Routh-Hurwitz method (algebraic criterion), Geometric criteria of stability, Exercises

Chapter 5: Correction of linear servo systems (3 weeks)
Notions of correction of linear servo systems,main correctors, P, PI, PID,Adjusting the PID corrector, Exercises

Chapter 6: Adaptive systems through learning (3 weeks)
Concepts on adaptive systems, different learning mechanisms, Exercises

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

Bibliographic references:

1. *Automatic control course Volume 2, Analog control regulation feedback, Jean-Louis Ferrier, Maurice Rivoire, Eyrolles.*
2. *Automatic: regulations and controls,Thierry Hansand Pierre Guyénot, June 20, 2014.*
3. *Automatic exercises, volume 2: Servo control, regulation, analog control.*
4. *ofMaurice RivoireAndJean-Louis Ferrier, Eyrolles.*

5. *Continuous controls and regulations. Volume 2, Analysis and synthesis, problems with resolutions, from Collective andElisabeth Boillot,January 1, 2002.*
6. *Industrial regulation, Modeling tools, control methods and architectures, Work directed by:Emmanuel Godoy, Collection:Technical and Engineering, Dunod/L'Usine Nouvelle, 2014 - 2nd edition - 552 pages, EAN13: 9782100717941.*
7. *Le Gallo, O. Automatic Mechanical Systems. Dunod. (2009).*
8. "ISMIN 1A Linear Automatic Yard".
9. "Electronics Volume 2: Looped linear, communication and filtering systems: Courses and exercises", François Manneville, Jacques Esquieu, Ed. Dunod.
10. “Automatic: Control of linear systems”, Philippe de Larminat, Ed. Hermes.

Semester: 2
Teaching unit: UED 1.2
Matter :Subject 1 of your choice
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Semester: 2
Teaching unit: UED 1.2
Matter :Subject 2 of your choice
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Semester: 2
Teaching unit: UET 1.2
Subject: Respect forstandards and rules of ethics and integrity.
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Develop students' awareness of respect for ethical principles and the rules that govern life at university and in the world of work. Raise awareness about respecting and valuing intellectual property. Explain to them the risks of moral evils such as corruption and how to combat them, alert them to the ethical issues raised by new technologies and sustainable development.

Recommended prior knowledge:

Ethics and professional conduct (the foundations)

Content of the material:

A. The respect of the rulesethics and integrity,

1. **Reminder on the MESRS Charter of Ethics and Professional Conduct:**Integrity and honesty. Academic freedom. Mutual respect. Requirement for scientific truth, objectivity and critical thinking. Equity.Rights andobligationsof the student,the teacher, administrative and technical staff,

2. Integrity and responsible research

- Respect for ethical principles in teaching and research
- Responsibilities in teamwork: Professional equality of treatment. Conduct against discrimination. The search for the general interest. Inappropriate conduct in the context of collective work
- Adopt responsible conduct and combat abuses: Adopt 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 world of work:

Legal confidentiality in business. Loyalty to the company. Responsibility within the company, Conflicts of interest. Integrity (corruption in the workplace, its forms, its consequences, methods of combating 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, communications in a congress, theses, dissertations, etc.)

II- Copyright

1. **Copyright in the digital environment**
Introduction. Copyrightdatabases, software copyright. Specific case of free software.
2. **Copyright in the Internet and e-commerce**
Domain name law. Intellectual property on the internet. E-commerce site law. Intellectual property and social networks.
3. **Patent**
Definition. Rightsin a patent. Usefulness of a patent. Therepatentability. Patent applicationin Algeria and around the world.

III- Protection and valorization of intellectual property

How to protect intellectual property. Violation of rights and legal tool. Vvaluation of intellectual property. Protection of intellectual propertyin 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,

Evaluation method:
Review: 100%

Bibliographic references:

1. Charter of university ethics and professional conduct, https://www.mesrs.dz/documents/12221/26200/Charte+fran ais+d f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce
2. Orders No. 933 of July 28, 2016 setting the rules relating to the prevention and fight against plagiarism
3. E. Prairat, On teaching ethics. Paris, PUF, 2009.
4. Racine L., Legault GA, Bégin, L., Ethics and engineering, Montreal, McGraw Hill, 1991.
5. Siroux, D., Deontology: Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004, p. 474-477.
6. Medina Y., Ethics, what will change in the company, Editions d'Organisation, 2003.
7. Didier Ch., Thinking about the ethics of engineers, Presses Universitaires de France, 2008.
8. Gavarini L. and Ottavi D., Editorial. of professional ethics in training and research, Research and training, 52 | 2006, 5-11.
9. Caré C., Morality, ethics, deontology. Administration and education, 2nd quarter 2002, n°94.
10. Jacquet-Francillon, François. Concept: professional ethics. Letélémaque, May 2000, n° 17
11. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
12. Galloux, JC, Industrial property law. Dalloz 2003.
13. Wagret F. and JM., Patent of invention, trademarks and industrial property. PUF 2001
14. Dekermadec, Y., Innovating through patents: a revolution with the internet. INSEP 1999
15. AEUTBM. The engineer 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" Grenoble 3 University and Paris West University Nanterre la Défense Nanterre, France
19. The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)

20. Alain bensoussan white paper – an open science in a digital republic direction 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. EmanuelaChiriac, Monique Filiatrault and André Régimbald. “student guide: intellectual integrity plagiarism, cheating and fraud… avoiding them and, above all, how to properly cite your sources” 2014
24. Publication of the University of Montreal. “Plagiarism prevention strategies”, Integrity, fraud and plagiarism, 2010
25. Pierrick Malissard “Intellectual property “origin and evolution” 2010.
26. The website of the World Intellectual Property Organizationwww.wipo.int.

V - Detailed program by subject for the S3 semester

Semester: 3
Teaching unit: UEF 2.1.1
Material: Deep internal combustion engine
VHS: 45h00 (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

- Understand the physical and chemical processes occurring during combustion and transfer in internal combustion engines. Understand the reaction of a given engine when changing one of its parameters using modeling.
- Build a model of an internal combustion engine. Optimize the sizing and adjustments of an engine under the constraints of efficiency, power, polluting emissions using an engine model.

Recommended prior knowledge:

Thermodynamics and mathematics of L1 and L2.

Material content:

Chapter 01: New techniques and improvement in engine performance (2 weeks)

1-1 Undersizing.
1-2 Variable distribution.
1-3 Variable compression ratio.
1-4 Miller-Atkinson cycle.
1-5 Stratified load.
1-6 HCCI concept.
1-7 PCCI concept.

Chapter 02: Fuel injection techniques **(2 weeks)**

2-1 Electronic management and engine diagnostics.
2-2 K-jetronic system.
2-3 D-jetronic system.
2-4 L-jetronic system.

Chapter03: Modeling combustion in engines **(4 weeks)**

3-1 Model a zone.
3-2 Two-zone model.
3-3 Multi-zone model.

Chapter 04: Formation of pollutants **(2 weeks)**

4-1 Carbon Monoxide.
4-2 Unburned hydrocarbons.
4-3 Formation of aromatics.
4-4 Soot formation.
4-5 Formation of NOx.

Chapter 05: Supercharging of MCI by turbocharger **(2 weeks)**

5-1 Maps (turbine, compressor, motor) and functional characteristics.
5-2 Engine adaptation – turbocharger.

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

Bibliographic references:

1. Heywood, JB Internal Combustion Engine Fundamentals. New York, NY, McGraw-Hill.Inc. 1983.
2. Ramos, JI Internal Combustion Engine Modeling. Hemisphere Publishing Corporation. 1989. P. 326-332.
3. Merker, GP et al Simulating of Combustion and pollutant formation for engine-development. Springer, 2004.
4. Lakshminarayanan P. A, Aghav, YV Modeling diesel combustion.Springer 2010.
5. Gasoline and diesel engine management "Diagnosis and repair T1, T2 and T3. Editions ETAI 2007.
6. Walls A. Supercharging of vehicle engines by turbocharger.
7. Delanette M. Automotive technology. technical editions and standardization. 1996.

Semester: 3
Teaching unit: UEF 2.1.1
Matter :Cryogenics
VHS: 45h (lesson: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

- Understand how gas liquefaction processes work;
- Know how to calculate the energy balances and performances of the different processes used in liquefaction;
- Know how to determine the working parameters of cryogenic fluids.

Recommended prior knowledge:
Thermodynamics; Energy conversion; Fluid mechanics.

Content of the material:

CHAPTER 1: REMINDER ON THE MAIN PROCESSES FOR OBTAINING LOW TEMPERATURES
(2 weeks)

1.1 Joule-Thomson expansion, isentropic expansion, exhaust process...
1.2 Concept of inversion temperature of a gas.
1.3 Inversion curve of a gas (diagram (T, P)).
1.4 Isenthalpic choke coefficient.
1.5 Isentropic bottleneck coefficient.

CHAPTER 2:LIQUEFACTION PROCESSESGAS (4 weeks)

2.1 General information on gas liquefaction
2.1.1 Importance and use of liquefied gases.
2.1.2 History of gas experiments.

2.2 Liquefaction by Joule-Thomson expansion
2.2.1 Linde process.
2.2.2 Linde process with preliminary cooling of the working gas.
2.2.3 Linde double-throttling process.

CHAPTER 3 CRYOGENIC CYCLES WITH GAS EXPANSION IN EXPANSIONS
(2 weeks)

3.1 Expansion of the gases in the regulators at the initial temperature level (at the compressor outlet).
3.2 Connecting the regulator to the intermediate temperature level.
3.3 Connecting the regulator to the lower temperature level (evaporator outlet).

CHAPTER 4 COMBINED CRYOGENIC CYCLES (2 weeks)

4.1 Combination of isenthalpic expansion and isentropic expansion on the same process.
4.2 Advantages of the combined cycle.

CHAPTER 5: STUDY OF INDUSTRIAL GAS LIQUEFACTION FACILITIES

(4 weeks)

5.1 Nitrogen and oxygen liquefaction installations.
5.2 Natural gas (LNG) liquefaction processes.
5.3 Liquefaction of Hydrogen.
5.4 Liquefaction of Helium.

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

Bibliographic references:

1. Pierre Petit: Separation and liquefaction of gases. Engineering technology. J3600;
2. Olivier Perrot: Refrigeration machines course. IUT of Saint Omer Dunkirk. Thermal Engineering and Energy Department. 2010 – 2011.
3. CRYOGENIC ENGINEERING Second Edition Revised and Expanded Thomas M. Flynn CRYOCO, Inc. Louisville, Colorado, USA2005.

Semester: 3
Teaching unit: UEF 2.1.2
Matter :Propulsion mechanics
VHS: 67h30 (Class: 3h00, tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:
The course essentially aims to familiarize the student with the constructive elements, operation and energy calculation of thermal propulsion turbomachines (gas turbine, turbojet, rocket engine).

Recommended prior knowledge
Basic notions of thermodynamics and gas dynamics.

Content of the material:

Chapter 1 : Principle of propulsion.
1. Airplanes.
2. The principles.
   1.1. Principle of lift (How does a plane fly?)
   1.2. Principle of propulsion (How does a plane move?)

Chapter 2 : Principles and performance of jet engines.
1. The push.
2. The forms of energy in a jet engine.
3. The powers.
4. Yields.

Chapter 3: Gas turbine.
1.Constructive elements of a gas turbine.
2.Working principle.
3.Energy calculation of a gas turbine.

Chapter 4: Aviation engine (Turbojets).
1. Operating principle of the turbojet.
2. The constructive elements of the turbojet.
3. The different types of the turbojet.
4.Analysis and calculation of a single flow turbojet.

Chapter 5: Rocket engine.
1.Thrust and principle of operation.
2. Launchers and Engines.
3. The descriptive parameters of an engine.
4. Fundamental relationships.

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

Bibliographic references:

1. Klaus Hünecke, Jet engines: fundamentals of theory, design, and operation, Zenith Imprint, 1997, 241 p.
2. Jean-Claude Thevenin, The turbojet, the engine of jet planes, AssociationAéronautique et Astronautique. France, 2004, 46 p.
3. Albin Bolcs. Thermal turbomachines (volumes 1 and 2), Lausanne 1993.
4. S. Candel. Fluid Mechanics Tom 3 (Exercises), Dunod 1995.
5. George p. Sutton, 0scar Biblarz, Rocket Propulsion Elements, JOHN WILEY & SONS, 2001.

Semester:3
Teaching unit: UEF 2.1.2
Matter :Heat exchangers
VHS: 45h (lesson: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Master the calculation of heat exchangers in steady and variable regimes.

Recommended prior knowledge:
Heat transfers, thermodynamics, mechanical construction.

Content of the material:

Chapter 1 :
1. General information on heat exchangers.
2. Constructive types and fluid flow configuration.

Chapter 2: Thermal calculation element
1. Overall heat transfer coefficient in a heat exchanger.
2. Fouling factor.
3. Analysis of a heat exchanger.

Chapter 3: Thermal calculation methods for exchangers
1. DTLM method.
2. ε-NUT method.

Chapter: 4 Thermal calculation of heat exchangers in non-stationary operating mode
1. Accumulation type exchanger.
2. Regenerative type exchanger.

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

Bibliographic references:

1. C. Bougriou, Calculations and technology of exchangers, Office of University Publications, 2010.
2. DQ Kern,Process heat transfer.McGraw-Hill: New York, 1984.
3. AP Frass,andM.N. Ozisik, Heat exchangers design, John Wiley, 1965.
4. V. Afgan, and EU Shlunder,Heat exchangers; Design and theory,McGraw-Hill: New York, 1974.
5. JG Vollier, Collier,Convective boiling and condensation heat transfer.McGraw-Hill: New York, 1981.
6. J.Padet, Thermal heat exchangers. .Global calculation methods with 11 solved problems. Elsevier, 1994.
7. A. Bejan, Heat transfer, New York. Wiley, 2003.
8. F. Incropera, Fundamentals of heat and mass transfer, 7th edition New York. Wiley, 2011.

Semester: 3
Teaching unit: UEM 2.1
Matter :CFDs and software
VHS: 45h (TP: 03:00)
Credits: 4
Coefficient: 2

Teaching objectives:

This subject provides the foundations necessary for the development and use of digital fluid mechanics codes MFN (we also frequently use the English term CFD, such as ComputationalFluid Dynamics). These bases are today extremely essential for mechanical master's students (energy option) to understand and optimize industrial installations, where flows coupled with thermal and material transfer play an essential role. Indeed, the teaching must be designed so that the student can understand the main characteristics of digital methods, use commercial code, analyze and exploit the results. Furthermore, emphasis must be placed on modeling the different laminar and turbulent flow regimes. The ANSYS/Fluent software, which was chosen in the program for all of the numerical exercises, is today the most widely used commercially throughout the world.

Recommended prior knowledge:
MDF, Thermodynamics.

Content of the material:

1. Presentation in the calculation room of the ANSYS/Fluent software and the resolution tree mode as well as the usual commands.

TP: Getting started with the software using an example of simulation of Rayleigh-Taylor instabilities.

2. Representation of turbulent flows. Concept of closure Reynolds tensor Simulation of turbulence – RANS models (k/epsilon).

TP: Flow around an obstacle (cylinder or sphere) of Von Carman type.

3. Solving the Navier-Stokes equations and SIMPLE algorithms – Purely convective transfer.

TP:natural convection in a differentially heated confined cavity.

4. Solving the Navier-Stokes equations and SIMPLE algorithms - Conducto-convective transfers.

TP: Numerical simulation of a double-tube counter-current heat exchanger.

5. Solving the Navier-Stokes equations and SIMPLE algorithms - Coupled convecto-diffusive transfers.

TP: Simulation of the diffusion of a chemical species in laminar regime.

6. Structured and unstructured meshes and Basics of the finite volume method.

TP: Numerical simulation of the phase change (solidification or fusion) in 2D of a pure substance.

Evaluation method:
ControlContinuous :100%,

Bibliographic references:

1. User guide to: Gambit, Mesh, Fluent, CFX, Origin and Tecplot.
2. For practical work: see ANSYS (Fluent or CFX).

Example:
https://confluence.cornell.edu/display/SIMULATION/FLUENT+Learning+Modules

Semester: 3
Teaching unit: UEM 2.1
Matter :Optimization
VHS: 37h30 (class: 1h30, practical work: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:
Become familiar with operations research models. Learn to formulate and solve optimization problems and master the appropriate techniques and algorithms.

Recommended prior knowledge:
Basic notions of mathematics. Linear algebra.Matrix algebra.

Content of the material:

Chapter I: Linear optimization **(3 weeks)**
- General formulation of a linear program
- Examples of linear programs (Production problem, Mixing problem, Cutting problem, Transport problem)
- Solving the problem using the Simplex method:
  - Basics and basic solutions of linear programs.
  - The simplex algorithm.
  - Initialization of the simplex algorithm (the two-phase method).

Chapter II: Non-linear optimization without constraint **(5 weeks)**
- Positivity, Convexity, Minimum.
- Gradient and Hessian.
- Necessary conditions for a minimum.
- Sufficient conditions for a minimum.
- Local methods.
- One-dimensional search methods.
- Gradient methods.
- Methods of conjugate directions.
- Newton's method.
- Quasi-Newton methods.

Chapter III: Nonlinear optimization with constraints **(4 weeks)**
- Lagrange multipliers.
- Karush-Kuhn-Tucker conditions.
- Penalty method.
- Sequential quadratic programming.

Chapter IV: Stochastic optimization methods **(3 weeks)**
- The genetic algorithm.
- The particle swarm method.

Organization of practical work: it is preferable that the TPs are direct applications in the field of mechanical construction.

TP 1: presentation of optimization reference functions in Matlab.

TP 2: Presentation of the optimtool optimization tool in matlab.
TP 3: Definition and plotting of the curves of some test functions in optimization.
TP 4: Resolution of a linear optimization problem without constraints.
TP 5: Resolution of a linear optimization problem with constraints.
TP 6: Nonlinear minimization without constraints.
TP 7: Nonlinear minimization without constraints with gradient and Hessian.
TP 8: Nonlinear minimization with equality constraints.
TP 9: Nonlinear minimization with inequality constraints.
TP 10: Minimization with equality and inequality constraints.
TP 11: Use of the optimtool or other tool to solve a nonlinear optimization problem with constraints.
TP 12: Minimization with constraints using the GA function.

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

Bibliographic references:

1. *E. Aarts & J. Korst, Simulated annealing and Boltzmann machines: A stochastic approach to combinatorial optimization and neural computing. John Wiley & Sons, New York, 1997.*
2. *D. Bertsekas, Nonlinear programming. Athena Scientific, Belmont, MA, 1999.*
3. *M. Bierlaire, Introduction to differentiable optimization. French-speaking polytechnic and university presses, Lausanne, 2006.*
4. *F. Bonnans, Continuous optimization: courses and corrected problems. Dunod, Paris, 2006.*
5. *F. Bonnans, JC Gilbert, C. Lemaréchal and C. Sagastizàbal, Digital optimization: theoretical and practical aspects. Springer, Berlin, 1997.*
6. *PG Ciarlet, Introduction to matrix numerical analysis and optimization. Masson, Paris, 1994.*
7. *E. Chong and S. Zak, An introduction to optimization. John Wiley & Sons, New York, 1995.*
8. *Y. Colette and P. Siarry, Multiobjective optimization. Eyrolles, Paris, 2002.*
9. *JC Culioli, Introduction to optimization. Ellipses, Paris, 1994.*
10. *J. Dennis & R. Schnabel, Numerical methods for unconstrained optimization and nonlinear equations. Prentice Hall, Englewood Cliffs, NJ, 1983.*
11. *R. Fletcher, Practical methods of optimization. John Wiley & Sons, New York, 1987.*
12. *P. Gill, W. Murray, & M. Wright, Practical optimization. Academic Press, New York, 1987.*

Semester: 3
Teaching unit: UEM 2.1
Subject: Heat exchanger PW
VHS:10:30 p.m. (P.W.: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Apply the knowledge acquired during the course and tutorials on Heat Exchangers to various types of heat exchangers. Verify results obtained through manual calculations against those obtained from the test bench.

Recommended prerequisite knowledge:
Proficiency in the knowledge gained during the course, familiarity with computer tools.

Subject content:
Familiarization with the available equipment in the laboratory.

PW 1: Shell and Tube Heat Exchanger.
PW 2: Tubular Heat Exchanger.
PW 3: Plate Heat Exchanger.
PW 4: Introduction to commercial software.

Assessment method:
Review: 100%.

Bibliographic references:
Brochures available in the laboratory.

Semester3:
Teaching unit: UED 2.1
Matter :Subject 1 of your choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester 3:
Teaching unit: UED 2.1
Matter :Matter2 to choose from
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 3
Teaching unit: UET 2.1
Subject 1:Documentary research and dissertation design
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Give the student the necessary tools to search for useful information to better use it in their end-of-studies project.Help them go through the different stages leading to the writing of a scientific document. Tell himthe importance of communication and itlearn to present the work carried out in a rigorous and educational manner.

Recommended prior knowledge:
Writing methodology, Presentation methodology.

Content of the subject:

Part I-: Documentary research:

Chapter I-1: Definition of the subject (2 weeks)
- Subject title.
- List of keywords relating to the subject.
- Gather basic information (acquisition of specialized vocabulary,meaning of terms, linguistic definition).
- The information sought.
- Take stock of your knowledge in the field.

Chapter I-2:Select information sources (2 weeks)
- Type of documents (Ldrunks, Theses, Memoirs, Periodical articles, Conference proceedings, Audiovisual documents, etc.).
- Type of resources (Libraries, Internet, etc.).
- Evaluate the quality and relevance of information sources.

Chapter I-3:Locate documents (1 week)
- Research techniques.
- Search operators.

Chapter I-4: To process information (2 weeks)
- Work organization.
- The starting questions.
- Summary of the documents retained.
- Links between different parties.
- Final plan of the documentary research.

Chapter I-5: Presentation of the bibliography (1 week)
- Systems for presenting a bibliography (The Harvard system, The Vancouver system, The mixed system, etc.).
- Presentation of documents.
- Citation of sources.

Part II: Memory Design

Chapter II-1: Plan and stages of the dissertation **(2 weeks)**

- Identify and delimit the subject (Summary).
- Problem and objectives of the dissertation.
- Other useful sections (Acknowledgments, Table of abbreviations, etc.).
- The introduction (The writing of*the introduction last).*
- State of the specialized literature.
- Formulation of hypotheses.
- Methodology.
- Results.
- Discussion.
- Recommendations.
- Conclusion and perspectives.
- Table of contents.
- The bibliography.
- Annexes.

Chapter II-2: Writing techniques and standards **(2 weeks)**

- Formatting.Numbering of chapters, figures and tables.
- Cover Page.
- Typography and punctuation.
- Writing. Scientific language: style, grammar, syntax.
- Spelling.Improved general language skills in terms of comprehension and expression.
- Back up, secure, archive your data.

Chapter II-3:Workshop : Critical study 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.
- Defense of a dissertation.

Chapter II-5: How to avoid plagiarism? **(1 week)**

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

- The quote.
- Paraphrasing.
- Indicate the complete bibliographic reference.

Evaluation method:

Review: 100%

Bibliographic references:

1. *M. Griselin et al., Guide to written communication, 2nd edition, Dunod, 1999.*
2. *JL Lebrun, Practical guide to scientific writing: how to write for the international scientific reader, Les Ulis, EDP Sciences, 2007.*
3. *HAS.Mallender Tanner, ABC of technical writing: instructions for use, user manuals, online help, Dunod, 2002.*
4. *M. Greuter, Write your dissertation or internship report well, L'Etudiant, 2007.*

5. *Mr. Boeglin, reading and writing in college. From the chaos of ideas to structured text. The Student, 2005.*
6. *M. Beaud, the art of the thesis, Editions Casbah, 1999.*
7. *M. Beaud, the art of the thesis, The discovery, 2003.*
8. *M. Kalika, Master's thesis, Dunod, 2005.*

Proposal of some discovery materials

Semester: x
Teaching unit: UED xx
Material: Tenergy transport and storage
VHS: 10:30 p.m. (Class: 1:30 a.m.)
Credits: 1
Coefficient: 1

Teaching objectives:

Recommended prior knowledge:

Content of the material:

Chapter 1. Different forms of energy.

Chapter 2. Energy management: production, transformation, transport and storage.

Chapter3. Transport of energy.
- 3.1 Transportation of fuels.
- 3.2 Transport of electrical energy.
- 3.3 Transport of hydraulic energy.
- 3.4 Transport of thermal energy.

Chapter4. Energy storage.
- 4.1 Interest.
- 4.2 Energy efficiency of energy storage.
- 4.3 Forms of energy storage.
  - 4.3.1 Mechanical storage: potential and kinetic (pumping, compressed air, flywheels, etc.).
  - 4.3.2 Electrochemical and electrostatic storage: batteries and accumulators.
  - 4.3.3 Chemical storage: hydrogen and methane
  - 4.3.4 Thermal and thermochemical storage: sensible heat, latent heat, energy by sorption.
  - 4.3.5 New storage technologies.
- 4.4 Cost of energy storage.

Evaluation method:
Review: 100%.

Bibliographic references:

Semester: x
Teaching unit: UED xx
Subject: Energy Audit
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Present the tools for carrying out an energy audit and allow students to acquire the knowledge necessary to carry out energy audits in different sectors of activity.

Recommended prior knowledge:

Thermodynamics, thermal transfer, Thermal machines.

Content of the material:

Chapter 1. General information on energy (2 weeks)
- Types and sources of energy
- Energy transport
- Algerian Energy Pricing System (electric and thermal)
- Algerian legislation and energy audit obligation

Chapter 2: Energy audit (4 weeks)
- Industrial sector
- Tertiary sector
- Building sector

Chapter 3: Energy audit methodology (4 weeks)
- Preliminary audit
- Detailed audit
- Recommendation of energy saving solutions
- Costing of solutions and return time
- Writing the audit report

Chapter 4: Implementation of an energy management system (2 weeks)
- The ISO 50001 standard

Chapter 5: Case study (3 weeks)

Evaluation method:
Review: 100%.

Bibliographic references:

1. The energy audit, PA Bernard, 1995.
2. Technical guide to energy audit, K. Moncef and M. Dominique, 2016.
3. Material and energy balances, G. Henda, 2012.
4. www.aprue.org.dz

Semester: x
Teaching unit: UED xx
Material: Renewable energy
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Have general knowledge of renewable energies.

Recommended prior knowledge:
Heat transfer, MDF, thermodynamics.

Content of the material:

Chapter 1.GENERAL (01 week)
Definitions and vocabulary: renewable energies, sustainable development, renewable energies in Algeria.

Chapter 2. WIND ENERGY (02 weeks)
II.1. The wind and its characteristics.
II.2.The different types of wind turbines.
II.3. Main constituents.
II.4. Geometric Profiles.
II.5. The operating parameters, Betz limit.
II.6. Uses.

Chapter 3. SOLAR ENERGY (Solar Project) (06 weeks)
Definitions: The solar deposit
III.1. Solar energy system.
III.2. Data relating to the sun and solar radiation, calculations of solar coordinates.
III.3. Notions of time, TSV, TSM, TU, TL.
III.5. Components and models for calculating solar radiation.
III.6. Thermal conversion of solar energy.
III.7. Photovoltaic conversion of solar energy.

Chapter 4. HYDRAULIC ENERGY (01 week)
IV.1. Definitions, water cycle in nature.
IV.2. Principle of operation.
IV.3. Types of dams, types of turbines used, types of power plants.

Chapter 5.GEOTHERMAL ENERGY **(02 weeks)**
V.1. Definitions, principle of technology.
V.2. Different types of geothermal deposits.
V.3. Uses.

Chapter 6. BIOMASS ENERGY (02 weeks)
VI.1. Definitions and origins.
VI.2. Constituents of biomass.
VI.3.Valuationthermochemical.
VI.4.Valuationchemical.
VI.5.Valuationbiological.

Evaluation method:
Review: 100%.

Bibliographic references:

1. M. Capderou: Solar Atlas of Algeria, University Publication Office, Algiers 1988.
2. JM. Chasseriaux: Thermal Conversion of Solar Radiation AFME 1984.
3. Y. Jannot: “Solar Thermal”, Courses And Exercises. October 2003.
4. R. Bernard, G. Menguy, M. Schwartz: Solar Radiation, Thermal Conversion and Application. Technical And Documentation 1998.
5. P.DE BRICHAMBAUT: Solar Radiation and Natural Radiative Exchanges, Gauthier-Villars 1983.
6. J. Dsssautel: Heliothermal Sensors, EDISUD 1979.
7. J. Taine, JPPetit: Thermal Transfers, Mechanics of Anisothermal Fluids, Bodas 1989.
8. Guide to Renewable Energy in Algeria, (MEM, DER, 2002).
9. S. Bragard: The solar water heater, from the study to the realization of sustainable development projects. Energy 2030 Agency SA
10. Daguenet Michel, “Solar Dryers: Theory and Practice” Unesco-1985.
11. CharreauA, Cavaille R. “Drying: Theory And Calculations”, Engineering Technique J2480.
12. HAS. A. Sfeir and G. Guarracino, “Solar Systems Engineering: Application to Habitat”, technical & Documentation-1981.
13. M. Villoz, A. Labouret, 'Photovoltaic Solar Energy' The Professional's Manual.
14. JADuffieAnd WA Beckman: “Solar Energy Thermal Processes”, Wiley-Interscience, New York (1974).
15. P. Chouard, H. Michel and MF Simon, “Thermal Assessment of a Solar House”, Collection of the EDF Studies and Research Department, Edition Eyrolles-1977.
16. JF Sacadura: “Initiation to Thermal Transfers”, Technique Et Documentation, Paris 1978.
17. W.HAS. Beckman, SA Klein and JA Duffie, “Solar Heating Design By The F-Cart Method” Edition Jhon Willey – New York 1977.
18. DuffieJa, Beckman WA, “Solar Engineeringof Thermal Processes”, John Wiley & Sons Inc, New York, -1980.
19. A.Labouret, G.Cumunel, JPBraun, B.Faraggi: Solar Cells, French Technical and Scientific Edition, Dunod Paris 2001.
20. R. Espic, “A Simple Formula for Estimating the Energy Savings Brought by a Solar Water Heater. » Promoclim Energy, Thermal Studies And… Volume 10 E, No. 4 - October 1979.
21. M. Dagaev, V. Demine, I. Klimishine and V. Tcharougin, “Astronomy”, MIR Moscow Edition. -1986, Translation of Valentin. Polonsky).
22. McadamsW. H, “Transmission of Heat. », ÉditionDunod, -2nd Edition, -1961Kays W. M & Crawford M. E, “Convective Heat and Mass Transfer”, Mc Graw Hill Series in Mechanical Engineering.
23. Abdelkrim Haddad, “Thermal Transfers”, Dar-El-Djazairia -2001.
24. M. Carlier, “General and Applied Hydraulics”, Collection of the Department of Electricity Studies and Research of France – Volume 14, Edition Eyrolles.
25. Jean Lemale."Geothermal Energy". The monitor. © Dunod, Paris 2009. ISBN 978-2-10-052879-0.
26. Technical Regulatory Document, ''Thermal Regulation of Residential Buildings - Rules for Calculating Heat Losses'', DTR C3-2', Booklet 1. CNERIB, Algiers, 1998.

Semester: x
Teaching unit: UED xx
Matter :Maintenance of energy installations
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Know the basics of industrial maintenance, as well as the failures of energy installations and their solutions.

Recommended prior knowledge:
Knowledge of energy installations;
Know the statistical laws (normal, exponential).

Content of the material:

1. Introduction to maintenance.
2. Definition of the main maintenance concepts.
3. Mathematical methods and tools for implementing maintenance actions.
4. Methodological tools for behavior analysis.
5. Software tools for maintenance (computer-assisted maintenance management).
6. TPM (total productive maintenance).
7. Maintenance of some energy installations (compressor, heat pump, condenser, etc.).

Evaluation method:
Review: 100%.

Bibliographic references:

1. Frédéric Tomala. Maintenance course. Systems management department. Advanced Engineering Studies;
2. François Manchy, Jean Pierre Vernier: Maintenance: methods and organizations. 3rd edition DUNOD;
3. F.Castellazi, D.Cogniel, Y.Gangloff: Memotech industrial maintenance. Edition ELeducalivre.

Semester: x
Teaching unit: UED xx
Matter :Electronic
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Recommended prior knowledge:

Content of the material:

Chapter 1. Preliminary concepts - Reminders

Chapter 2. Permanent sinusoidal regime

Chapter3. The diode and its applications

Chapter4. The bipolar transistor and its applications

Chapter5. The linear integrated circuit and its applications

Evaluation method:
Review: 100%.

Semester: x
Teaching unit: UED xx
Matter :Electrical engineering
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Recommended prior knowledge:

Content of the material:

Chapter 1. Three-phase systems.

Chapter 2. The transformer.

Chapter 3. Direct current machines.

Chapter4. Synchronous machines.

Chapter 5. Asynchronous machines.

Evaluation method:
Review: 100%.

Semester: x
Teaching unit: UED xx
Matter :Hydraulic and Pneumatic Systems
VHS: 10:30 p.m. (1h30 class)
Credits: 1
Coefficient: 1

Teaching objectives:

The objective of the program is to have students learn a body of knowledge essential and necessary for the physical understanding of hydraulic and pneumatic systems. This begins with the description of the different organs (cylinders, distributors, valves, etc.), until the establishment of the hydraulic or pneumatic diagrams

Recommended prior knowledge:

Knowledge of fluid mechanics, machine components and the laws of physics.

Content of the material:

Chapter 1 : Introduction and reminders **(2 weeks)**

- Hydraulic fluids: Mineral oils, synthetic oils and their characteristics.
- Calculation of load losses.
- Air and oil filtration.
- Air and oil filters: Types and choices.

Chapter 2 : Pumps, compressors and hydraulic motors **(6 weeks)**

- Pumps: Types, construction and choice of axial piston pumps, radial piston pumps, vane pumps, gear pumps, screw pumps.
- Pump calculation elements.
- Compressors: Types, construction and choice of compressors.
- Compressor calculation elements.
- Hydraulic motors: Axial piston motors, radial piston motors, gear motors, vane motors, slow cam and roller motors.
- Calculation elements for hydraulic motors.
- Single acting cylinders, double acting cylinder, double acting double rod cylinder, telescopic cylinder, rotary cylinder.
- Calculation of the cylinders.

Chapter 3: Other organs used in
Hydraulic and pneumatic circuits **(3 weeks)**

- Distributors: Types, construction, selection and ordering. (direct, indirect).
- Pressure relief valves: Types, construction, selection and ordering. (direct, indirect).
- Flow limiters: Types, construction, choice and order. (direct, indirect).
- Accumulators and tanks: Types, calculation and choice.
- Pipes: Materials, dimensions.
- Sensors: force, speed, position, temperature, etc.

Chapter 4: Practical Examples: **(4 weeks)**

- Establishment of hydraulic and pneumatic diagrams.
- Calculation of hydraulic and pneumatic circuits.

Evaluation method:

Review: 100%.

Bibliographic references:

1. *Jacques Faisandier, Hydraulic and pneumatic mechanisms, Collection:Technical and Engineering, Dunod/L'Usine Nouvelle, 2013.*
2. *José RoldanViloria, Cheat Sheet: Industrial Hydraulics, L'Usine Nouvelle - Dunod.*
3. *R.-C. Weber, Safety of pneumatic systems, Festo Edition, 2012.*
4. *Simon Moreno,Edmond Peulot, Pneumatics in automated production systems, Editor(s):Casteilla, 2001.*

Semester:x
Teaching unit UED xx
Subject: Industrial maintenance
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

- Plan, estimate, direct or carry out the installation, start-up, troubleshooting, modification and repair of devices, tools and machines;
- Design, implement and manage preventive maintenance methods and processes;
- Organize and carry out the modification or improvement of machines and production systems;

Recommended prior knowledge:
Basic notions of industrial maintenance.

Content of the material:

Chapter 1: Generalities and Definitions on industrial maintenance **(2 weeks)**
Introduction - Importance of maintenance in the company - Objectives of maintenance in the company - Maintenance policies in the company.

Chapter 2 :Organization of maintenance (1 week)
Place of maintenance in the general structure - Internal organization of maintenance -Human means -Material means

Chapter 3:Maintenance methods and techniques (2 weeks)
General – Maintenance methods (corrective; systematic preventive and conditional preventive) – Maintenance operations – Related maintenance activities.

Chapter 4:Availability and FMD concepts (4 weeks)
Reliability – maintainability - Availability - Notions of FMD - Costs and analysis of an FMD policy - Analysis of failure modes, their effects and their criticality (FMEA)

Chapter 5:Machine file and technical documentation (1 weeks)
Purpose of documentation -Machine file.

Chapter 6:Maintenance costs (3 weeks)
Composition of costs - Cost analysis and ABC method - Optimal preventive maintenance - Example of calculating MTBF - Optimization of replacement using the probability model - Choice between maintenance and replacement - Economic lifespan - Decommissioning of equipment.

Chapter 7: CMMS (2 weeks)

Evaluation method:
Review: 100%.

Bibliographic references:

1- *Jean-Claude Francastel, Maintenance engineering: From design to operation of an asset, Editor(s):Dunod,The New Factory, Collection :Technique and engineering - Industrial management, 2009.*
2- *François Castellazzi,Yves Gangloff,Denis Cogniel, Industrial maintenance: Maintenance of industrial equipment, Editions: Cateilla, 2006.*
3- *Pascal Denis,Pierre Boye,André Bianciotto, Guide to industrial maintenance, Editions: Delagrave, 2008.*
4- *Serge Tourneur, Corrective maintenance in electrical equipment and installations: Troubleshooting and measurement, Editions: Cateilla, 2007.*
5- *Jean-Marie Auberville, Industrial Maintenance From Basic Maintenance to Optimization of Safety, Editions: Ellipse.*
6- *Sylvie Gaudeau, Hassan Houraji, Jean-Claude Morin, Julien Rey, Maintenance of industrial equipment. Volume 1: From component to system. Editions: Hachette.*