	الجمهورية الجزائرية الديمقراطية الشعبية République Algérienne Démocratique et Populaire وزارة التعليم العالي والبحث العلمي Ministère de l'Enseignement Supérieur et de la Recherche Scientifique	Université Yahia fares de Medea	

TRAINING OFFER
L.M.D.
ACADEMIC Bachelor
NATIONAL PROGRAMME
2025
(3rd update)

	Faculty or institute	Department
Yahia fares University of Médéa	**Faculty Of Technology**	**Mechanical Engineering Department**

Area of study	Sector	Specialty
Sciences and Technologies	***Mechanical Engineering***	***Energising***

Semesterly organization sheets for the teachings of the Energy specialty.

Semestre 1

Teaching unit.	Subjects	Credits	Coefficient	Weekly Scheduled Hours			Semesterly Scheduled Hours (15 weeks)	Supplementary Work in Consultation (15 weeks)	Evaluation Method	
	Title			Lectures	TUT	PW			Continuous Assessment	Final Exam
Fondamental TU Code : UEF 1.1.1 Crédits : 10 Coefficient : 5	Analysis 1	6	3	1h30	3h00		67h30	82h30	40%	60%
	Algèbra 1	4	2	1h30	1h30		45h00	55h00	40%	60%
Fondamental TU Code : UEF 1.1.2 Crédits : 12 Coefficient : 6	Elements of Mechanics	6	3	1h30	3h00		67h30	82h30	40%	60%
	Structure of Matter	6	3	1h30	3h00		67h30	82h30	40%	60%
Méthodological UT Code : UEM 1.1 Crédits : 6 Coefficient : 4	PW Elements of Mechanics	2	1			1h30	22h30	22h30	100%	
	PWStructure of Matter	2	1			1h30	22h30	22h30	100%	
	Computer Structure and Applications	2	2	1h30		1h00	37h30	22h30	40%	60%
Transversal TU Code : UET 1.1 Crédits : 2 Coefficient : 2	Ethical and Deontological Dimension (Fundamentals)	1	1	1h30			22h30	02h30		100%
	Careers in Science and Technology	1	1	1h30			22h30	02h30		100%
Semester total 1		**30**	**17**	**9h00**	**12h00**	**4h00**	**375h00**	**375h00**		

Semester 2

Teaching unit.	Subjects	Credits	Coefficient	Weekly Scheduled Hours			Semesterly Scheduled Hours (15 weeks)	Supplementary Work in Consultation (15 weeks)	Evaluation Method	
	Title			Lectures	TUT	PW			Continuous Assessment	Final Exam
Fondamental TU Code : UEF 1.2.1 Crédits : 10 Coefficient : 5	Analysis2	6	3	1h30	3h00		67h30	82h30	40%	60%
	Algèbra 2	4	2	1h30	1h30		45h00	55h00	40%	60%
Fondamental TU Code : UEF 1.2.2 Crédits : 12 Coefficient : 6	Electricity and Magnetism	6	3	1h30	3h00		67h30	82h30	40%	60%
	Thermodynamics	6	3	1h30	3h00		67h30	82h30	40%	60%
Méthodological TU Code : UEM 1.2 Crédits : 6 Coefficient : 4	PW Electricity and Magnetism	2	1			1h30	22h30	22h30	100%	
	PW Thermodynamics	2	1			1h30	22h30	22h30	100%	
	Introduction to Programming	2	2	1h30		1h00	37h30	22h30	40%	60%
Transversal TU Code : UET 1.2 Crédits : 2 Coefficient : 2	Free Software - Open Source	2	2	1h30	1h30		45h00	05h00	40%	60%
Semester total 2		**30**	**17**	**9h00**	**10h30**	**5h30**	**375h00**	**375h00**		

Semester 3

Teaching unit.	Subjects	Credits	Coefficient	Weekly Scheduled Hours			Semesterly Scheduled Hours (15 weeks)	Supplementary Work in Consultation (15 weeks)	Evaluation Method	
	Title			Lectures	TUT	PW			Continuous Assessment	Final Exam
Fondamental TU Code : UEF 2.1.1 Crédits : 10 Coefficient : 5	Analysis 3	6	3	1h30	3h00		67h30	82h30	40%	60%
	Waves and Vibrations	4	2	1h30	1h30		45h00	45h00	40%	60%
Fondamental TU Code : UEF 2.1.2 Crédits : 9 Coefficient : 5	Fluid Mechanics 1	5	3	1h30	1h30	1h30	67h30	82h30	40% (20%TD+20%TP)	60%
	Rational Mechanics	4	2	1h30	1h30		45h00	45h00	40%	60%
Méthodological TU Code : UEM 2.1 Crédits : 10 Coefficient : 6	Probability and Statistics	4	2	1h30	1h30		45h00	45h00	40%	60%
	Python Programming	2	2	1h30		1h30	45h00	27h30	40%	60%
	Technical Drawing	2	1			1h30	22h30	27h30	100%	
	TP Waves and Vibrations	2	1			1h00	22h30	17h50	100%	
Discovery TU Code : UED 2.1 Crédits : 1 Coefficient : 1	Metrology	1	1	1h30			22h30	02h30		100%
Total semestre 3		**30**	**17**	**10h30**	**9h00**	**5h30**	**375h00**	375h00		

Semester 4

Teaching unit.	Subjects	Credits	Coefficient	Weekly Scheduled Hours			Semesterly Scheduled Hours (15 weeks)	Supplementary Work in Consultation (15 weeks)	Evaluation Method	
	Title			Lectures	TUT	PW			Continuous Assessment	Final Exam
FondamentalTU Code : UEF 2.2.1 Crédits : 6 Coefficient : 3	Thermodynamics 2	4	2	1h30	1h30		45h00	55h00	40%	60%
	Mechanical Manufacturing	2	1	1h30			22h30	27h30		100%
Fondamental TU Code : UEF 2.2.2 Crédits : 10 Coefficient : 5	Complex Analysis	4	2	1h30	1h30		45h00	55h00	40%	60%
	Strength of Materials 1	4	2	1h30	1h30		45h00	55h00	40%	60%
	Industrial Electricity	2	1	1h30			22h30	27h30		100%
Méthodological TU Code : UEM 2.2 Crédits : 11 Coefficiens : 6	Numerical Methods	5	3	1h30	1h30	1h30	67h30	82h30	40% (20%TD+20%TP)	60%
	Computer-Aided Design	2	1			1h30	22h30	27h30	100%	
	TP Strength of Materials	2	1			1h00	15h00	10h00	100%	
	TP Mechanical Manufacturing	2	1			1h30	22h30	27h30	100%	
Discovery TU Code : UED 2.2 Crédits : 1 Coefficients : 1	Materials Science	1	1	1h30			22h30	02h30		100%
Transversal TU Code : UET 2.2 Crédits : 2 Coefficient : 2	Information and Communication Techniques	2	2	1h30	1h30 d'atelier		45h30	5h00	40%	60%
Semester total 4		**30**	**17**	**12h00**	**6h00**	**7h00**	**375h00**	**375h00**		

Semester 5

Teaching unit.	Subjects	Credits	Coefficient	Weekly Scheduled Hours			Semesterly Scheduled Hours (15 weeks)	Supplementary Work in Consultation (15 weeks)	Evaluation Method	
	Title			Lectures	TUT	PW			Continuous Assessment	Final Exam
Fondamental TU Code : UEF 3.1.1 Crédits : 10 Coefficient : 5	Fluid Mechanics 2	6	3	3h00	1h30		67h30	82h30	40%	60%
	Heat Transfer 1	4	2	1h30	1h30		45h00	60h00	40%	60%
Fondamental TU Code : UEF 3.1.2 Crédits : 8 Coefficient : 4	Turbomachines 1	4	2	1h30	1h30		45h00	60h00	40%	60%
	Energy Conversion	4	2	1h30	1h30		45h00	55h00	40%	60%
Méthodological TU Code : UEM 3.1 Crédits : 9 Coefficient : 5	TP Heat Transfer	2	1			1h30	22h30	27h30	100%	
	TP Turbomachines 1	2	1			1h30	22h30	27h30	100%	
	TP Energy Conversion	2	1			1h30	22h30	27h30	100%	
	Measurement and Instrumentation	3	2	1h30		1h00	15h00	27h30	40%	60%
Discovery TU Code : UED 3.1 Crédits : 2 Coefficient : 2	Elements of Machines	1	1	1h30			22h30	02h30		100%
	Regulation and Control	1	1	1h30			22h30	02h30		100%
Transversal TU Code : UET 3.1 Crédits : 1 Coefficient : 1	Environment and Sustainable Development	1	1	1h30			22h30	02h30		100%
Semester total 5		**30**	**17**	**13h30**	**6h00**	**5h30**	**375h00**	**375h00**		

Semester 6

Teaching unit.	Subjects	Credits	Coefficient	Weekly Scheduled Hours			Semesterly Scheduled Hours (15 weeks)	Supplementary Work in Consultation (15 weeks)	Evaluation Method	
	Title			Lectures	TUT	PW			Continuous Assessment	Final Exam
Fondamental TU Code : UEF 3.2.1 Crédits : 10 Coefficient : 5	Turbomachines 2	6	3	3h00	1h30		67h30	82h30	40%	100%
	Internal Combustion Engines	4	2	1h30	1h30		45h00	55h00	40%	100%
Fondamental TU Code : UEF 3.2.2 Crédits : 8 Coefficient : 4	Refrigeration Machines and Heat Pumps	4	2	1h30	1h30		45h00	55h00	40%	100%
	Heat Transfer 2	4	2	1h30	1h30		45h00	55h00	40%	100%
Méthodological TU Code : UEM 3.2 Crédits : 9 Coefficient : 5	End-of-Cycle Project	4	2			2h30	37h30	42h30	100%	
	TP Refrigeration Machines and Heat Pumps	2	1			1h30	22h30	27h30	100%	
	TP Internal Combustion Engines	1	1			1h30	22h30	27h30	100%	
	T TP Regulation and Control	2	1			1h30	22h30	22h30	100%	
Discovery TU Code : UED 3.2 Crédits : 2 Coefficient : 2	Renewable Energies	1	1	1h30			22h30	02h30		100%
	Cryogenics	1	1	1h30			22h30	02h30		100%
Transversal TU Code : UET 3.2 Crédits : 1 Coefficient : 1	Entrepreneurship and Start-up	1	1	1h30			22h30	02h30		100%
Semester total 6		**30**	**17**	**12h00**	**6h00**	**7h00**	**375h00**	**375h00**		

Detailed Program by Subject

Semester: 1
Teaching Unit: UEF 1.1.1
Subject 3: Analysis 1
VHS: 67h30 (Lectures: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Subject Content:

Chapter 1: Properties of the Set $\mathbb{R}$

1. Bounded above, below, and bounded sets.
2. Maximum and minimum elements.
3. Supremum and infimum.
4. Absolute value, floor function.

Chapter 2: Real Numerical Sequences

1. Convergent sequences.
2. Comparison theorems.
3. Monotone convergence theorem.
4. Subsequences.
5. Adherent sequences.
6. Particular sequences (arithmetic, geometric, recursive).

Chapter 3: Real Functions of One Variable

1. Limits and continuity of functions.
2. Derivative and differential of a function.
3. Applications to elementary functions (power, exponential, hyperbolic, trigonometric, logarithmic).

Chapter 4: Limited Developments

1. Limited developments.
2. Taylor formula.
3. Limited developments of functions.

Chapter 5: Simple Integrals

1. Review of Riemann integral and antiderivative computation.

Evaluation Method:

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

References:

1- K. Allab, Eléments d'analyse, Fonction d'une variable réelle, 1re& 2e années d'université, Office des Publications universitaires.

2- J. Rivaud, Algèbre : Classes préparatoires et Université Tome 1, Exercices avec solutions, Vuibert.

3- N. Faddeev, I. Sominski, Recueil d'exercices d'algèbre supérieure, Edition de Moscou

Semester: 1
Teaching Unit: UEF 1.1.2
Subject 3: Algebra 1
VHS: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Sets, Relations, and Functions (5 weeks)

1. Set theory.
2. Order relations, equivalence relations.
3. Injective, surjective, bijective functions and inverses: function definition, direct image, inverse image, function characteristics.

Chapter 2: Complex Numbers (5 weeks)

1. Definition of complex numbers.
2. Representations: algebraic, trigonometric, geometric, exponential.
3. Roots of complex numbers: square roots, equation solving, nth roots.

Chapter 3: Vector Spaces (5 weeks)

1. Vector spaces, bases, dimension (definitions and elementary properties).
2. Linear applications, kernel, image, rank.

Evaluation Method:
Continuous assessment: 40%, Final exam: 60%.

References:

1. J. Rivaud, Algèbre : Classes préparatoires et Université Tome 1, Exercices avec solutions, Vuibert.
2. N. Faddeev, I. Sominski, Recueil d'exercices d'algèbre supérieure, Edition de Moscou
3. M. Balabne, M. Duflo, M. Frish, D. Guegan, Géométrie – 2^{e} année du 1er cycle classes préparatoires, Vuibert Université.
4. B. Calvo, J. Doyen, A. Calvo, F. Boshet, Exercices d'algèbre, 1er cycle scientifique préparation aux grandes écoles 2^{e} année, Armand Colin – Collection U.

Semester: 1
Teaching Unit: UEF 1.1.3
Subject: Elements of Mechanics
VHS: 67h30 (Lectures: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Subject Content: Physics 1 (Mechanics)

Chapter I: Review

- Dimensional analysis
- Vector analysis

Chapter II: Kinematics

- Reference frame concept
- Space motion study (general case, circular, rectilinear, intrinsic coordinates)
- Coordinate systems (Cartesian, polar, cylindrical, spherical)
- Relative motion (velocity and acceleration composition laws)

Chapter III: Dynamics

- Inertia principle, inertial mass, Galilean reference frame
- Momentum – Conservation of momentum principle
- Force concept
- Newton's laws
- Differential equation of motion
- Force types (gravitational, elastic, viscous, etc.)

Chapter IV: Rotational Motion

- Angular momentum, moment of force
- Angular momentum theorem and moment of inertia
- Applications: torsion, pendulum, etc.

Chapter V: Work, Power, Energy

- Work and power of a force
- Kinetic energy
- Potential energy (gravitational, elastic, etc.) and equilibrium states
- Conservative and non-conservative forces
- Energy conservation
- Impulse and collisions (elastic and inelastic)

Evaluation Method:
Continuous assessment: 40%, Final exam: 60%.

Semester: 1
Teaching Unit: UEF 1.1.4
Subject 3: Structure of Matter
VHS: 67h00 (Lectures: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Subject Content:

Chapter 1: Fundamental Concepts (2 weeks)
States and macroscopic characteristics of matter, phase changes, atom/molecule/mole/Avogadro's number concepts, atomic mass unit, atomic/molecular molar mass, molar volume, Lavoisier's mass conservation law, chemical reactions, qualitative/quantitative aspects of matter.

Chapter 2: Main Constituents of Matter (3 weeks)
Faraday's experiment linking matter and electricity, atomic constituents and properties (mass, charge), Rutherford's planetary model, atomic characteristics (symbol, atomic number Z, mass number A, protons/neutrons/electrons), isotopy and relative abundance, isotope separation via mass spectrometry (Bainbridge spectrograph), nuclear binding/cohesion energy, nuclear stability.

Chapter 3: Radioactivity – Nuclear Reactions (2 weeks)
Natural radioactivity (α, β, γ radiation), artificial radioactivity and nuclear reactions, radioactive decay kinetics, radioactivity applications.

Chapter 4: Electronic Structure of the Atom (2 weeks)
Wave-particle duality, light-matter interaction, Bohr's hydrogen atom model, hydrogen atom in wave mechanics, multi-electron atoms in wave mechanics.

Chapter 5: Periodic Classification of Elements (3 weeks)
Mendeleev's periodic classification, modern periodic table, evolution and periodicity of physico-chemical properties, calculation of atomic/ionic radii, successive ionization energies, electron affinity, electronegativity (Mulliken scale) using Slater's rules.

Chapter 6: Chemical Bonds (3 weeks)
Covalent bonding in Lewis theory, polarized covalent bonding, dipole moment and partial ionic character, molecular geometry (Gillespie/VSEPR theory), chemical bonding in quantum model.

Evaluation Method:
Continuous assessment: 40%, Final exam: 60%.

References:

1. Ouahes, Devallez, Chimie Générale, OPU.

2. S.S. Zumdhal& coll., Chimie Générale, De Boeck Université.

3. Y. Jean, Structure électronique des molécules : 1 de l'atome aux molécules simples, 3^{e} édition, Dunod, 2003.

4. F. Vassaux, La chimie en IUT et BTS.

5. A. Casalot& A. Durupthy, Chimie inorganique cours 2ème cycle, Hachette.

6. P. Arnaud, Cours de Chimie Physique, Ed. Dunod.

7. M. Guymont, Structure de la matière, Belin Coll., 2003.

8. G. Devore, Chimie générale : T1, étude des structures, Coll. Vuibert, 1980.

9. M. Karapetiantz, Constitution de la matière, Ed. Mir, 1980.

Semester: 1
Teaching Unit: UEM 1.1.1 **Subject: Mechanics**
Elements Labs
VHS: 22h30 (Labs: 3h00)
Credits: 2
Coefficient: 1

Laboratory Experiments (Physics 1):

- Measurement and uncertainty calculations
- Free fall
- Inclined plane
- Circular motion
- Simple pendulum
- Oscillating pendulum
- Solid-solid friction

Evaluation Method:
Continuous assessment: 100%.

Semester: 1
Teaching Unit: UEM 1.1.2 **Subject 3: Structure of Matter Labs**
VHS: 22h30 (Labs: 1h30)
Credits: 2
Coefficient: 1

Laboratory Experiments:

TP .1: Preliminary: Laboratory safety and glassware description.
TP .2: Water phase changes (liquid to solid, liquid to vapor).
TP .3: Determination of amount of substance.
TP .4: Molecular mass determination.
TP .5: Uncertainty calculation - Ionic radius determination.
TP .6: Partial molar volumes in binary solutions.
TP .7: Qualitative cation analysis (Groups 1, 2, 3, 4).
TP .8: Qualitative anion analysis.
TP .9: Metal ion identification by flame test.
TP .10: Benzoic acid separation and recrystallization.
TP .11: Construction and study of compact structures.
TP .12: Study of ionic structures.

Evaluation Method:
Continuous assessment: 100%.

References:

1. Ouahes, Devallez, Chimie Générale, OPU.
2. S.S. Zumdhal& coll., Chimie Générale, De Boeck Université.

3. Y. Jean, Structure électronique des molécules : 1 de l'atome aux molécules simples, 3e édition, Dunod, 2003.

4. F. Vassaux, La chimie en IUT et BTS.

5. A. Casalot& A. Durupthy, Chimie inorganique cours 2ème cycle, Hachette.

6. P. Arnaud, Cours de Chimie Physique, Ed. Dunod.

7. M. Guymont, Structure de la matière, Belin Coll., 2003.

8. G. Devore, Chimie générale : T1, étude des structures, Coll. Vuibert, 1980.

9. M. Karapetiantz, Constitution de la matière, Ed. Mir, 1980.

Semester: 1
Teaching Unit: UEM 1.1.3
Subject 3: Computer Structure and Applications
VHS: 45h00 (Lectures: 1h30, Labs: 1h30)
Credits: 2
Coefficient: 2

Subject Content:

Part 1: Introduction to Computing (5 weeks)

1. Definition of computing
2. Evolution of computing and computers
3. Information coding systems
4. Computer operating principles
5. Hardware components
6. System software
    - Operating systems (Windows, Linux, Mac OS, etc.)
    - Programming languages, application software

Part 2: Algorithm and Program Concepts (10 weeks)

1. Algorithm concept
2. Flowchart representation
3. Program structure
4. Problem analysis approach
5. Data structures: constants/variables, data types
6. Operators: assignment, relational, logical, arithmetic, operation priorities
7. Input/output operations
8. Control structures: conditional, repetitive

Computer Labs 1:

Labs illustrate course concepts and follow this sequence:

- Initiation and familiarization with computer hardware and OS (exploring OS features)
- Introduction to programming environment (editing, assembly, compilation, etc.)
- Application of programming techniques covered in class

Evaluation Method:

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

References:

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

3- Thomas H. Cormen, Algorithmes: Notions de base, 2013.

Semester: 1
Teaching Unit: UET 1.1.1
Subject: Ethical and Deontological Dimension (Foundations)
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

I. Fundamental Concepts (2 weeks)
Definitions:

1. Morality
2. Ethics
3. Deontology ("Theory of Duty")
4. Law
   A. Distinction between ethics and morality
   B. Distinction between ethics and deontology

II. References (2 weeks)
Philosophical references, religious references, civilization evolution, institutional references.
III. University Campus (3 weeks)
University campus concept, regulatory texts, campus fees, campus actors.
IV. University Values (2 weeks)
Social values, community values, professional values.
V. Rights and Duties (2 weeks)
Student rights/duties, teacher rights/obligations, researcher obligations, administrative/technical staff obligations.
VI. University Relations (2 weeks)
University relations concept, student-teacher relations, student-student relations, student-staff relations, student-association relations.
VII. Practices (2 weeks)
Good practices for teachers, good practices for students.
Evaluation Method:
Final exam: 100%.
References:

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

Semester: 1
Teaching Unit: UED 1.1.1
Subject 3: Careers in Science and Technology
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

1. Engineering Sciences Overview
Engineering profession history and 21st-century challenges, job search by keyword, simple job description creation (title, company, main activities, required skills: knowledge, know-how, interpersonal).

2. Electronics, Telecommunications, Biomedical, Electrotechnical, Electromechanical, Optics & Precision Mechanics Tracks
Definitions, applications (smart homes, automotive embedded systems, video surveillance, mobile telephony, fiber optics, scientific instrumentation, medical imaging, giant mirrors, contact lenses, electrical energy transport/distribution, power plants, energy efficiency, industrial maintenance, elevators, wind turbines), specialist roles.

3. Automation and Industrial Engineering Tracks
Definitions, applications (automated production lines, CNC machine tools, robotics, inventory management, goods traffic control, quality management), specialist roles.

4. Process Engineering, Hydrocarbons, Petrochemical Industries Tracks
Definitions, applications (pharmaceuticals, food processing, leather/textiles, biotechnology, chemical/petrochemical, plastics, energy sector), specialist roles.

5. Industrial Hygiene & Safety (HSI), Mining Engineering Tracks
Definitions, applications (safety of people/property, environmental issues, mineral resource exploration/exploitation), specialist roles.

6. Climate Engineering, Transport Engineering Tracks
Definitions, applications (air conditioning, smart buildings, transport safety, traffic management, road/air/sea transport), specialist roles.

7. Civil Engineering, Hydraulics, Public Works Tracks (2 weeks)
Definitions, applications (construction materials, major road/rail infrastructure, bridges, airports, dams, drinking water supply/sanitation, hydraulic flows, water resource management, public works, territory planning, smart cities), specialist roles.

8. Aeronautics, Mechanical Engineering, Maritime Engineering, Metallurgy Tracks
Definitions, applications (aeronautics, avionics, automotive industry, ports, dikes, industrial equipment production, steelmaking, metal transformation), specialist roles.

Group Work:
Create job description sheets for each track from job postings (e.g., onisep.fr, indeed.fr, pole-emploi.fr). Optional tutoring/mentoring by PhD students/alumni.

Individual Student Work:
Job description sheets, scientific film viewing with written/oral report (format and bonus points at teacher's discretion).

Evaluation Method:
Final exam: 100%.

Bibliographic References:

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

Semester: 2
Teaching Unit: UEF 1.2.1
Subject: Analysis 2
VHS: 67h30 (Lectures: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 2

Subject Content:

Chapter 1: Ordinary Differential Equations
1. First-Order ODEs
1.1 Historical note
1.2 Physical models leading to differential equations
1.3 General definitions
1.4 General concepts: general solution, particular solution
1.5 Separable equations
1.6 Homogeneous first-order equations: definition, resolution
1.7 Equations reducible to homogeneous form
1.8 Bernoulli equation: definition, resolution

2. Second-Order ODEs
2.1 Historical note
2.2 Linear homogeneous equations: definitions, properties
2.3 Second-order linear homogeneous with constant coefficients

- Distinct real roots
- Complex roots
- Repeated real root
  2.4 nth-order linear homogeneous with constant coefficients
  2.5 Second-order linear nonhomogeneous: variation of parameters
  2.6 Second-order linear nonhomogeneous with constant coefficients
- Nonhomogeneous term P(x)eaxP(x)e^{ax}P(x)eax, various root cases
- Nonhomogeneous term sin⁡(bx)\sin(bx)sin(bx) or cos⁡(bx)\cos(bx)cos(bx), various root cases

Chapter 2: Functions of Several Variables
Limits, continuity, partial derivatives, differentiability
2.1 Historical note
2.2 Domain of definition
2.3 Limit concept (neighborhoods, directional vs. general limits)
2.4 Continuity
2.5 First-order partial derivatives, higher-order partials
2.6 Differentiability (relation to partial derivatives and continuity)
2.7 Differential of two-variable functions
2.8 Partial derivatives of composite functions
2.9 Taylor formula for two variables
2.10 Differentiable optimization in R2\mathbb{R}^2R2 (local/global optima, necessary/sufficient conditions)

Chapter 3: Multiple Integrals
1. Double Integrals
1.1 Definition

1.2 Examples
1.3 Properties (linearity, order preservation, additivity)
1.4 Fubini's theorem (bounded domain)
1.5 Computation (direct, change of variables)
1.6 Applications: center of gravity, moment of inertia

2. Triple Integrals
2.1 Generalization from double integrals
2.2 Computation (direct, change of variables, volumes)
2.3 Applications: center of gravity, moment of inertia

Evaluation Method:
Continuous assessment: 40%, Final exam: 60%.

References:

[1] KadaAllab, Eléments d'Analyse. Office des publications Universitaires. Ben Aknoun. Alger 1984
[2] N. Piskounov, Calcul différentiel et integral. Editions Mir. Moscou 1978

[3] J. Dixmier, Cours de mathématiques du premier cycle. 1ère année. Gauthiers-Villars. Paris 1976

[4] R. Murray Spiegel. Théorie et applications de l'Analyse. McGraw-Hill, Paris 1973

[5] G. Flory, Topologie, Analyse. Exercices avec solutions. Vuibert. Paris 1978

Semester: 2
Teaching Unit: UEF 1.2.2
Subject: Algebra 2
VHS: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content

Chapter 1: Vector spaces

- Definition (over $\mathbb{R}$and $\mathbb{C}$).
- Vector subspaces.
- Sum of subspaces.
- Complementary subspaces.
- Linearly independent set. Linearly dependent set. (Finite) basis.

Chapter 2: Linear maps

- Definition (operations).
- Kernel and image.
- Rank of a linear map.
- Rank theorem.
- Characterization of injectivity, surjectivity and bijectivity.

Chapter 3: Matrices, associated matrices and determinants

- Definition (as an array of numbers). Special matrices.
- Operations on matrices. The vector space of matrices.
- Determinants (definition for order 2 and 3 and generalization) and properties.
- Invertible matrix.
- Matrix representation of a linear map.
- Correspondence between operations on linear maps and operations on matrices.
- Change-of-basis matrix (transition matrix).
- Effect of a change of basis on the matrix of a linear map.

Chapter 4: Systems of linear equations

- Definitions and interpretations.
- Cramer systems (general case).

Chapter 5: Matrix reduction

- Eigenvalues.
- Eigenvectors.
- Characteristic polynomials. Cayley–Hamilton theorem.
- Characterization of diagonalizable matrices.
- Characterization of triangularizable matrices.
- Applications of reduction.

Mode d'évaluation:

Contrôle continu: 40% ; Examen: 60%.

Références

[1] A.KUROSH : Cours d'algèbre supérieure. Edition MIR MOSCOU.
[2] D.FADEEV et I.SOMINSKY : Recueil d'exercices d'algèbre supérieure. Edition MIR MOSCOU.
[3] J.RIVAUD : Exercices avec solutions tome 1 VUIBERT.
[4] J.RIVAUD : Exercices avec solutions tome 2 VUIBERT.
[5] LEBSIR HABIB : Travaux dirigés d'algèbre générale. Dar el-houda Ain M'LILA.
[6] Jean-Pierre Escofier : Toute l'algèbre de la licence. Cours et exercices corrigés. Dunod.
[7] J.Lelong-Ferrand, J.M.Arnaudiès : Cours de mathématiques. Tome 1 Algèbre 3^{e}édition. Classes préparatoires 1ercycle universitaire. Dunod.
[8] A.DONEDDU : ALGEBRE ET GEOMETRIE 7 Mathématiques spéciales Premier cycle universitaire. VUIBERT.
[9] COLLET Valérie : MATHS Toute la deuxième année. ellipses

Semester: 2
Teaching Unit: UEF 1.2.3
Subject: Electricity and Magnetism
VHS: 67h30 (Lectures: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Subject Content

Chapter 1: Electrostatic field and potential

- The point charge.
- Electric force and Coulomb's law.
- Electric field and potential (discrete charge distributions).
- Electric dipole: electric field and potential.
- Action of the electric field on a dipole (orientation and equilibrium states).
- Electric field and potential (continuous charge distributions).
- Gauss's theorem.

Chapter 2: Conductors

- Basic properties.
- Induced charge and electrostatic influence phenomena.
- Electrostatic pressure.
- Capacitors, capacitance (different types), stored energy.

Chapter 3: Electric current

- Notions of current intensity and current density.
- Resistance and Ohm's law, Joule's law (Joule heating).

Chapter 4: Magnetostatics

- Introduction.
- Magnetic force and the Lorentz law.
- Action of a magnetic field on an electric current.
- Magnetic field produced by a steady current: the Biot–Savart law.
- Circulation of the magnetic field.
- Curl of the magnetic field and Ampère's law.
- Magnetic flux through a closed loop and induction.
- Maxwell's equations.

Evaluation method:

Continuous assessment 40%; Final exam 60%.

Références bibliographiques :

- Physique, 2. Electricité et magnétisme, Harris Benson, éditions de Boeck.
- Physique, 2. Electricité et magnétisme, Eugene Hecht, éditions de Boeck.
- Physique Générale, Electricité et magnétisme, Douglas Giancoli, éditions de Boeck

Semester: 2
Teaching Unit: UEF 1.2.4
Subject: Thermodynamics
VHS: 67h30 (Lectures: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Subject Content

Chapter I: Basic notions in thermodynamics

I.1 Mathematical review of partial derivatives
I.2 Properties and states of a system
I.3 Processes, equilibrium and thermodynamic cycles
I.4 Density, specific volume
I.5 Pressure, temperature and energy

Chapter II: Thermodynamic properties of pure substances

II.1 The ideal gas
II.2 Real gas behavior
II.3 Corresponding states and residual deviations
II.4 Properties of liquids and solids

Chapter III: Fundamental concepts of thermodynamics

III.1 First law (energy conservation) and applications
III.2 Entropy and the second law
III.3 Entropy balance and irreversibility
III.4 Properties of free energy and thermodynamic equilibrium
III.5 Chemical potential and fugacity

Chapter IV: Equilibria of physical processes

IV.1 Phase equilibria of a pure substance
IV.2 Thermodynamic properties of phase transitions
IV.3 Ideal behavior of mixtures (gaseous, liquid and solid)
IV.4 Phase equilibria of a component in an ideal mixture
IV.5 Ideal solubility and partition coefficient

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

Bibliographic references:

[1] Smith, E.B, Basic Chemical Thermodynamics, 2nd ed., Clarendon Press, Oxford, 1977.
[2] Rossini, F. D., Chemical Thermodynamics, Wiley, New York, 1950. Florence,
[3] Stanley I.Sandler,Chemical and Engineering Thermodynamics, Wiley, New York, 1977.
[4] Elliot,J, Lira C.T, Introductory chemical engineering Thermodynamics , Prentice –Hall (1999)
[5] Lewis G.N., Randal M., Thermodynamics, Mac Graw Hill
[6] Hougen O.A., Watson K.M., Chemical process principles, Vol II: thermodynamics John Wiley and sons

Semester: 2
Teaching Unit: UEM 1.2.1
Subject 1: Electricity and Magnetism Labs
VHS: 45h00 (Labs: 1h30)
Credits: 2
Coefficient: 1

Subject Content

Minimum of 5 lab experiments (3 h every 15 days)

- Presentation of instruments and measurement tools (voltmeter, ammeter, rheostat, oscilloscopes, signal generator, etc.).
- Kirchhoff's laws (loop law and node law).
- Thevenin's theorem.
- Connection and measurement of inductances and capacitances.
- Charging and discharging of a capacitor.
- Oscilloscope lab (use and measurements).
- Laboratory exercises on magnetism.

Evaluation method:

Continuous assessment: 100%

Semester: 2
Teaching Unit: UEM 1.2.2
Subject: Thermodynamics Labs
VHS: 22h30 (Labs: 3h00)
Credits: 2
Coefficient: 1

Thermodynamics Laboratory Practical Sessions:

TP No. 1: Study of the equation of state of an ideal gas.
TP No. 2: Calorimeter water equivalent.
TP No. 3: Specific heat: specific heat of liquid and solid substances.
TP No. 4: Study of the solidification of pure water.
TP No. 5: Latent heat: latent heat of fusion of ice.
TP No. 6: Determination of the latent heat of vaporization.
TP No. 7: Reaction heat: determination of the energy released by a chemical reaction (HCl/NaOH).
TP No. 8: Thermodynamic functions of an acid–base equilibrium.
TP No. 9: Study of the variation of pressure with temperature at liquid–gas equilibrium for a pure system: water.
TP No. 10: Vapor pressure of a solution.
TP No. 11: Phase equilibrium diagram for a binary system.
TP No. 12: Phase equilibrium diagram for a ternary system.

Evaluation method:
Continuous assessment: 100%.

Semester: 2
Teaching Unit: UEM 1.2.3
Subject 3: Introduction to Programming
VHS: 45h00 (Lectures: 1h30, Labs: 1h30)
Credits: 2
Coefficient: 2

Subject Ccontent:

Chapter 1 — Introduction to Computer Science and Programming (1 Week)
- History of programming languages.
- Notion of algorithm and programming.
- The program development process.
- Presentation of the development environment (IDE).

Chapter 2 — Structure of a C Program and Data Types (2 Weeks)
- Fundamental structure of a C program.
- Variables and constants.
- Primitive data types (int, float, double, char).
- Arithmetic and logical operations.

Chapter 3 — Input/Output and Expressions (2 Weeks)
- Use of `printf()` and `scanf()` functions.
- Data formatting.
- Expressions and order of evaluation.
- Type conversions.

Chapter 4 — Conditional and Iterative Control Structures (3 Weeks)
- `if-else` statements.
- Comparison operators.
- Logical operators.
- `switch-case` structure.
- `while` and `do-while` loops.
- `for` loop.
- Loop nesting.
- `break` and `continue` statements.

Chapter 5 — Functions, Arrays, and Strings (3 Weeks)
- Function definition and declaration.
- Parameter passing.
- Return values.
- Recursive functions.
- Array declaration and usage.
- Multidimensional arrays.
- Character strings in C.
- Standard string library functions.

Chapter 6 — Pointers and Dynamic Allocation (2 Weeks)
- Concept of memory address.
- Address (`&`) and dereference (`*`) operators.
- Memory allocation and deallocation (`malloc`, `free`).
- Relationship between arrays and pointers.

Chapter 7 — Structures and Enumerations (2 Weeks)
- Definition of structured types (`struct`).
- Member access.
- Arrays of structures.
- Enumerations (`enum`).

Detailed content for Lab Sessions (TP):

TP 1: Environment Familiarization

- IDE installation (Code::Blocks, Visual Studio Code with C extensions).
- First program: "Hello World."
- Compilation and execution.
- Simple error correction.

TP 2: Variables and Expressions

- Variable declaration and initialization.
- Arithmetic operators.
- Simple calculations and result display.

TP 3: Conditional and Iterative Control Structures

- Implementation of programs using `if-else`.
- Use of `switch-case`.
- Comparison and logical operators.
- Implementation of `while`, `do-while`, and `for` loops.
- Creation of counters and accumulators.
- User input validation.

TP 4: Functions

- Function creation and calling.
- Passing parameters by value.
- Code organization into functions.

TP 5: One-dimensional and Multidimensional Arrays

- Array manipulation.
- Search and sorting (simple algorithms).
- Passing arrays to functions.
- Matrix creation and manipulation.
- Matrix operations.

TP 6: Character Strings

- String manipulation using functions from the `string.h` library.
- Text processing.

TP 7: Pointers and Dynamic Allocation

- Pointer usage.
- Memory allocation and deallocation.
- Dynamic arrays.

TP 8: File Operations

Assessment method:

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

Bibliographical references:

1. Kernighan, B. W., & Ritchie, D. M. (2022). *Le langage C : Norme ANSI*, 2e édition. Dunod.
2. Perry, G. (2007). Exercices corrigés sur le Langage C, 2e édition . Dunod.
3. Delannoy, C. (2016). *Programmer en langage C : Cours et exercices corrigés*, 5eme édition. Eyrolles.
4. Tanenbaum, A. S. (2008). Systèmes d'exploitation Avec plus de 400 exercices, 3e édition. Pearson.
5. *Yves*, M. (2009). C en action Solutions et exemples pour les programmeurs en C, 2e édition, ENI, ISBN10 : 2746052563.
6. Ressourcesenligne :

- *Learn C Programming* sur https://www.learn-c.org/
- *C Programming* sur https://www.tutorialspoint.com/cprogramming/

Semester: 2
Teaching Unit: UET 1.2
Subject 1: Free and Open Source Software
VHS: 45h00 (Lectures: 1h30, Workshops: 1h30)
Credits: 2
Coefficient: 2

Subject Content:

Chapter 1 — Foundations of Free Software (2 weeks)

- History of the Free Software and Open Source movement.
- Distinction between "Free Software" and "Open Source."
- Philosophy of Richard Stallman and the GNU Project.
- Economic and social impact of free software in Algeria and globally.

Chapter 2 — Legal Framework and Licenses (2 weeks)

- Introduction to copyright as applied to software.
- Principal free licenses: GPL, LGPL, BSD, MIT, Apache.
- License compatibility.
- Implications for Algerian educational institutions and businesses.

Chapter 3 — Free Operating Systems (3 weeks)

- Introduction to GNU/Linux.
- Presentation of distributions adapted to the educational context.
- Principles of installation and basic configuration.
- Fundamental commands and package management.

Chapter 4 — Free Office Solutions (3 weeks)

- LibreOffice as an alternative to Microsoft Office:
    - Writer (word processing)
    - Calc (spreadsheet)
    - Impress (presentation)
- Open document formats.
- Migration of existing documents.
- Configuration for the Algerian context (language, formats).

Chapter 5 — Creative and Development Solutions (3 weeks)

- Graphical alternatives: GIMP, Inkscape.
- Development tools: Free IDEs, Git.
- Web tools: Free web browsers, open source CMS.
- Free databases: MySQL/MariaDB, PostgreSQL.

Chapter 6 — Perspectives and Future of Free Software (2 weeks)

- Open source communities and contribution methods.
- Business models for free software.
- Public policies and free software in Algeria.
- Professional opportunities related to free software.

Workshops (Ateliers)

Atl. 1: Linux Discovery

- Installation of a Linux distribution in a virtual machine.
- Basic configuration and system customization.
- Interface navigation and use of basic commands.

Atl. 2: Software Management under Linux

- Use of package managers.

- Software installation and updating.
- Configuration of software repositories.

Atl. 3: Migration to LibreOffice

- Installation and configuration of LibreOffice.
- Document creation and editing with Writer.
- Conversion of proprietary formats to open formats.
- Creation of templates adapted to student needs.

Atl. 4: Free Spreadsheets and Presentations

- Advanced use of Calc (formulas, charts).
- Presentation creation with Impress.
- Compatibility with existing formats.
- Collaborative document work.

Atl. 5: Image Processing and Graphics

- Use of GIMP for image editing.
- Graphic creation with Inkscape.
- Comparison with corresponding proprietary tools.
- Completion of a simple graphic project.

Atl. 6: Web and Free Databases

- Installation and configuration of an open source CMS (WordPress, Joomla).
- Configuration of a MariaDB database.
- Creation of a simple website.
- Basic security implementation.

Atl. 7: Collaborative Development

- Use of Git for version control.
- Configuration of a free development environment.
- Participation in a mini-collaborative project.
- Use of a software forge (GitHub, GitLab).

Assessment mode:

Exam 100%

Bibliographical references:

1. Stallman, R. (2002). "Free as in Freedom : Richard Stallman's Crusade for Free Software", 1st Edition,O'Reilly Media.
2. Mathieu , N. (2012). "Reprenez le contrôle à l'aide de Linux - 2e édition". EYROLLES.
3. Stutz, M. (2001). "The Linux Cookbook: Tips and Techniques for Everyday". No StarchPress.
4. Collectif Eni. (2009). " Initiation aux logiciels libres OpenOffice.org 3, Firefox 3 et Thunderbird". ENI Editions.
5. François, E. (2009). "L'économie du logiciel libre". EYROLLES.
6. Marie, C. (2014). " Des logiciels libres pour le Maghreb ? Des opportunités théoriques aux réalités empiriques ". Institut de recherche sur le Maghreb contemporain.
1. Documentation du projet GNU: https://www.gnu.org/doc/doc.html
2. Stallman, R. M. (2002). *Free Software, Free Society: Selected Essays of Richard M. Stallman*.GNU Press.

Semester: 3
Teaching Unit: UEF 2.1.1
Subject: Analysis 3
VHS: 67h30 (Lectures: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Subject Content:

Chapter 1: Vector Analysis

1. Scalar fields and vector fields: Definition of a scalar field; Definition of a vector field.
2. Circulation and Gradient: Definition of the circulation of a vector field; Definition of the gradient of a scalar field; Definition of fields of gradients.
3. Divergence and Curl: Definition of the divergence of a vector field; Definition of the curl of a vector field; Definition of fields of curls; Definition of the Laplacian of a scalar field.
4. Scalar and vector potentials.
5. Line integrals (curvilinear integrals).
6. Calculation of line integrals.
7. Green's formula.
8. Conditions for a line integral to be path-independent (conservative fields).
9. Surface integrals.
10. Calculation of surface integrals.
11. Stokes' formula.
12. Ostrogradsky's formulas (Divergence Theorem).

Chapter 2: Numerical and Power Series

I - Numerical Series

1. Generalities: Partial sum. Convergence, divergence, sum, and remainder of a convergent series.
2. Necessary condition for convergence.
3. Properties of convergent numerical series.
4. Series with positive terms:
   4.1 Convergence criteria: Necessary and sufficient condition for convergence.
   4.2 Comparison test: Theorem and consequence (Equivalence rule).
   4.3 D'Alembert's ratio test: Theorem.
   4.4 Cauchy's root test: Theorem.
   4.5 Cauchy's integral test: Theorem.
5. Series with arbitrary terms:
   5.1 Alternating series: Definition of an alternating series; Leibniz's theorem (Alternating Series Test).
   5.2 Absolutely convergent series: Definition; Theorem: Absolute convergence implies convergence (CVA ⇒ CVS).
   5.3 Conditionally convergent series: Definition and examples.
   5.4 Abel's test: Theorem (First criterion for series).

II - Power Series (Series Entières)

1. Definition of a power series, Abel's Lemma, Radius of convergence; Determination of the radius of convergence, Hadamard's rule.
2. Properties of power series: Linearity and product of two power series; Normal convergence of a power series of a real variable over any segment included in the open interval of convergence; Continuity of the sum over the open interval of convergence; Term-by-term integration and differentiation of a power series over its interval of convergence.
3. Power series expansion around zero for a real-variable function: Functions expandable in a power series over the open interval of convergence; Taylor–Maclaurin series for a C^∞ function; Uniqueness of the power series expansion.

4. Applications: Establishing power series expansions for common functions; Finding solutions to first- and second-order ordinary differential equations with variable coefficients in the form of a power series.

Chapter 3: Fourier Series

1. General definitions.
2. Fourier coefficients.
3. Functions expandable into a Fourier series.
4. Dirichlet's theorem.
5. Parseval's equality.
6. Application: Simple examples of Sturm–Liouville problems.

Chapter 4: Fourier and Laplace Transforms

I - Fourier Transforms

1. The Fourier integral.
2. Complex form of the Fourier integral.
3. Definitions and initial properties: Definition of the Fourier transform and its inverse; Derivative of the Fourier transform.

II - Laplace Transform

1. Definition of the Laplace transform.
2. Properties of the Laplace transform (Uniqueness, Linearity, Scaling factor, Differentiation, Integration, Theorems).
3. Common Laplace transforms.
4. Solving differential equations using the Laplace transform.

Evaluation Modalities:

Final Exam = 60%; Continuous Assessment (CC) = 40%.

Bibliographic references:

1. Med El Amrani, Suites et séries numériques, Ellipses.
2. François Liret ; mathématiques en pratiques, cours et exercices; Dunod. (f.p.v ; Int. Mult. Séries…)
3. Marc Louis, Maths MP-MP, Ellipses. (Int. Doubles)
4. Denis Leger, PSI. Exercices corrigés Maths, Ellipses. (Séries de Fonctions, Entières, Fourier…)
5. Charles-Michel Marle, Philippe Pilibossian, Sylvie Guerre- Delabrière, Ellipse. (Suites, Séries, Intégrales).
6. Fabrice Lembiez Nathan, Tout en un, Exercices de maths.
7. Valerie Collet, Maths toute la deuxième année, 361 exercices, rappels de cours, trucs et astuces, ellipses.
8. A.Monsouri, M.K.Belbarki. Elément d'analyse. Cours et exercices résolus. 1er cycle universitaire. Chiheb. (Intégrales doubles et triples, Séries, Transformations de Fourier et de Laplace, Equations aux dérivées partielles du 2iéme ordre). 9. B.DEMIDOVITCH. Recueil d'exercices et de problèmes d'analyse mathématiques.11iéme édition. Ellipses. (Fonctions de plusieurs variables, Séries, Intégrales multiples)

Semester: 3
Teaching Unit: UEF 2.1.1
Subject 2: Waves and Vibrations
VHS: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content

Preamble: This course is divided into two parts: the Waves section and the Vibrations section, which can be approached independently. Given the substantial content of this course, it is recommended that Electrical Engineering students (Group A) cover the material in the order: Waves, then Vibrations. Conversely, for students in Groups B and C (Civil Engineering, Mechanical Engineering, and Process Engineering), it is advisable to start with Vibrations. In any case, the instructor is expected to make every effort to cover both parts. We recall that this course is intended for engineering professions in the Science and Technology domain. Therefore, the instructor is encouraged to skim over any parts of the course requiring demonstrations or extensive theoretical development, focusing solely on the applied aspects. Furthermore, the demonstrations can be assigned as auxiliary work to students as part of their personal coursework. Refer to section "G - Student Evaluation through Continuous Assessment and Personal Work" in this training outline for further guidance.

Part A: Vibrations

Chapter 1: Introduction to Lagrange's Equations (2 weeks)
- 1.1 Lagrange's Equations for a particle:
- 1.1.1 Lagrange's Equations (the Euler–Lagrange equations).
- 1.1.2 Case of conservative systems.
- 1.1.3 Case of velocity-dependent friction forces (damping).
- 1.1.4 Case of a time-dependent external force.
- 1.2 Multi-degree-of-freedom systems.

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

Chapter 3: Forced oscillations of single-degree-of-freedom systems (1 week)
- 3.1 Differential equation.
- 3.2 Mass-spring-damper system.
- 3.3 Solution of the differential equation:
- 3.3.1 Harmonic excitation.
- 3.3.2 Periodic excitation.
- 3.4 Mechanical impedance.

Chapter 4: Free oscillations of two-degree-of-freedom systems (1 week)
- 4.1 Introduction.
- 4.2 Two-degree-of-freedom systems.

Chapter 5: Forced oscillations of two-degree-of-freedom systems (2 weeks)
- 5.1 Lagrange's Equations (for coupled systems).

5.2 Mass-spring-damper systems.
5.3 Impedance.
5.4 Applications.
5.5 Generalization to n-degree-of-freedom systems.

Part B: Waves

Chapter 1: One-dimensional propagation phenomena (2 weeks)

1.1 Generalities and basic definitions.
1.2 Propagation equation (the wave equation).
1.3 Solution of the propagation equation.
1.4 Sinusoidal progressive wave.
1.5 Superposition of two sinusoidal progressive waves.

Chapter 2: Vibrating strings (2 weeks)

2.1 Wave equation (for a string).
2.2 Harmonic progressive waves.
2.3 Free oscillations of a finite-length string.
2.4 Reflection and transmission.

Chapter 3: Acoustic waves in fluids (1 week)

3.1 Wave equation.
3.2 Speed of sound.
3.3 Sinusoidal progressive wave.
3.4 Reflection–Transmission.

Chapter 4: Electromagnetic waves (2 weeks)

4.1 Wave equation.
4.2 Reflection–Transmission.
4.3 Different types of electromagnetic waves.

Evaluation method:

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

Bibliographical references:

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

Semester: 3
Teaching Unit: UEF 2.1.2
Subject 1: Fluid Mechanics
VHS: 67h30 (Lectures: 1h30, Tutorials: 1h30, Labs: 1h30)
Credits: 5
Coefficient: 3

Subject Content

Chapter 1 — Fluid Properties (3 weeks)

1. Physical definition of a fluid: States of matter, particulate matter (dispersions, suspensions, emulsions).
2. Ideal fluid, real fluid, compressible fluid, and incompressible fluid.
3. Density (mass density) and specific gravity.
4. Fluid rheology, fluid viscosity, and surface tension of a fluid.

Chapter 2 — Fluid Statics (4 weeks)

1. Definition of pressure; pressure at a point within a fluid.
2. Fundamental law of fluid statics.
3. Level surface (isobaric surface).
4. Pascal's theorem.
5. Calculation of pressure forces: Flat plates (horizontal, vertical, inclined); center of pressure; instruments for measuring static pressure; measurement of atmospheric pressure, barometer, Torricelli's law.
6. Pressure in superimposed non-miscible fluids.

Chapter 3 — Dynamics of Ideal Incompressible Fluids (4 weeks)

1. Steady flow.
2. Continuity equation.
3. Mass flow rate and volume flow rate.
4. Bernoulli's theorem, cases with and without work exchange (e.g., pumps/turbines).
5. Applications to flow and velocity measurement: Venturi meters, diaphragms, Pitot tubes, etc.
6. Euler's theorem.

Chapter 4 — Dynamics of Real Incompressible Fluids (4 weeks)

1. Flow regimes, Reynolds experiment.
2. Dimensional analysis, Vashy-Buckingham theorem (Pi theorem), Reynolds number.
3. Linear head losses and minor (singular) head losses, Moody diagram.
4. Generalization of Bernoulli's theorem to real fluids.

Practical Work (Laboratory Sessions):

TP No. 1: Viscometer.

TP No. 2: Determination of linear and singular head losses.

TP No. 3: Flow rate measurement.

TP No. 4: Water hammer (pressure surge) and mass oscillation.

TP No. 5: Verification of Bernoulli's theorem.

TP No. 6: Jet impact force measurement.

TP No. 7: Flow through an orifice.

TP No. 8: Flow visualization around an obstacle.

TP No. 9: Determination of the Reynolds number: Laminar and turbulent flow.

Evaluation method:

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

Bibliographical references

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

Semester: 3
Teaching Unit: UEF 2.1.2
Subject 2: Rational Mechanics
VHS: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Mathematical Review (Elements of Vector Calculus) (1 week)

Chapter 2: Generalities and Basic Definitions (2 weeks)

2.1 Definition and physical meaning of force.
2.2 Mathematical representation of force.
2.3 Operations on force (composition, decomposition, projection).
2.4 Types of forces: punctual, linear (distributed), surface, and volume forces.
2.5 Classification of forces: internal forces and external forces.
2.6 Mechanical models: the material point and the rigid body.

Chapter 3: Statics (3 weeks)

3.1 Axioms of statics.
3.2 Constraints, supports, and reactions.
3.3 Axiom of constraints (Principle of Virtual Work applied to constraints).
3.4 Conditions for equilibrium:
3.4.1 Concurrent forces.
3.4.2 Parallel forces.
3.4.3 Coplanar forces.

Chapter 4: Kinematics of the Rigid Body (3 weeks)

4.1 Brief review of kinematic quantities for a material point.
4.2 Kinematics of the rigid body:
4.2.1 Translational motion.
4.2.2 Rotational motion about a fixed axis.
4.2.3 Planar motion.
4.2.4 Compound motion.

Chapter 5: Mass Geometry (3 weeks)

5.1 Mass of a material system:
5.1.1 Continuous system.
5.1.2 Discrete system.
5.2 Integral formulation of the center of mass:
5.2.1 Definitions (linear, surface, and volume cases).
5.2.2 Discrete formulation of the center of mass.
5.2.3 GULDIN's theorems (Pappus's second theorem).
5.3 Moment of inertia and product of inertia of solids.
5.4 Inertia tensor of a solid:
5.4.1 Special cases.
5.4.2 Principal axes of inertia.
5.5 Huygens' theorem (Parallel Axis Theorem).
5.6 Moment of inertia of solids with respect to an arbitrary axis.

Chapter 6: Dynamics of the Rigid Body (3 weeks)

6.1 Brief review of dynamic quantities for a material point.
6.2 Elements of rigid body kinetics:
6.2.1 Linear momentum.
6.2.2 Angular momentum.
6.2.3 Kinetic energy.
6.3 Equation of dynamics for a rigid body.
6.4 Angular momentum theorem.
6.5 Kinetic energy theorem.
6.6 Applications:
6.6.1 Pure translation case.
6.6.2 Rotation about a fixed axis case.
6.6.3 Combined translation and rotation case.

Evaluation method:

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

Bibliographical references: (According to documentation availability at the institution, websites, etc.)

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

Semester: 3
Teaching Unit: UEM 2.1
Subject 1: Probability & Statistics
VHS: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Part A — Statistics

Chapter 1: Basic Definitions (1 week)

A.1.1 Concepts of population, sample, variables, and categories (modalities).
A.1.2 Different types of statistical variables: qualitative, quantitative, discrete, continuous.

Chapter 2: Single-variable Statistical Series (3 weeks)

A.2.1 Count (frequency), relative frequency, percentage.
A.2.2 Cumulative count, cumulative frequency.
A.2.3 Graphical representations: bar chart, pie chart, stick plot; frequency polygon (and frequency curve). Histogram. Cumulative curves (ogives).
A.2.4 Measures of location (central tendency).
A.2.5 Measures of dispersion: range, variance and standard deviation, coefficient of variation.
A.2.6 Measures of shape (e.g., skewness and kurtosis).

Chapter 3: Two-variable Statistical Series (3 weeks)

A.3.1 Data tables (contingency tables). Scatter plot.
A.3.2 Marginal and conditional distributions. Covariance.
A.3.3 Pearson's linear correlation coefficient. Regression line and Mayer's line.
A.3.4 Regression curves, regression corridor, and correlation ratio.
A.3.5 Curve fitting / functional fitting.

Part B — Probability

Chapter 1: Combinatorics (1 week)

B.1.1 Arrangements.
B.1.2 Combinations.
B.1.3 Permutations.

Chapter 2: Introduction to Probability (2 weeks)

B.2.1 Algebra of events.
B.2.2 Definitions (events, sample space, etc.).
B.2.3 Probability spaces.
B.2.4 General probability theorems.

Chapter 3: Conditioning and Independence (1 week)

B.3.1 Conditional probability.
B.3.2 Independence.
B.3.3 Bayes' formula.

Chapter 4: Random Variables (1 week)

B.4.1 Definitions and properties.
B.4.2 Cumulative distribution function (CDF).

B.4.3 Mathematical expectation (mean).
B.4.4 Covariance and moments.

Chapter 5: Common Discrete and Continuous Probability Laws (3 weeks)

Common distributions: Bernoulli, Binomial, Poisson, etc.; Uniform, Normal (Gaussian), Exponential, etc.

Assessment:

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

Bibliographical references:

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

Semester: 3
Teaching Unit: UEM 2.1.2
Subject 2: Python Programming
VHS: 45h00 (Lectures: 1h30, Labs: 1h30)
Credits: 2
Coefficient: 2

Subject Content:

Chapter 1: Installing and Using Python

Chapter 2: Basic Notions

2-A. Interactive mode and script mode:

2-A-1. Python as a calculator.

2-A-2. Use of operators: +, -, *, /, // (integer division), % (modulo), and ** (exponentiation).

2-A-3. Operator precedence.

2-B. Variables and Data Types:

2-B-1. Variable initialization, variable modification, compound assignment.

2-B-2. Data types: Numbers (integers, floats), Characters, Strings.

2-B-3. Type conversion (using the `str()` function).

2-C. Built-in Functions:

2-C-1. Using functions from the `math` module (e.g., `abs`, `max`, `min`, `pow`, `round`, `sin`, `sqrt`, `log`, `exp`, `acos`).

2-C-2. The `print()` function.

2-C-3. Formatted output (using the `format()` method).

2-C-4. The `input()` function.

2-C-5. Function importation.

2-D. Source Code:

2-D-1. Variable naming rules.

2-D-2. Comments.

Chapter 3: Conditional Structures

3-1. Conditional forms: Minimal `if`, `if-else`, and complete `if-elif-else`.

3-2. Limitations of the simple `if` condition.

3-3. Comparison operators.

3-4. Predicates and Boolean logic.

3-5. Keywords: `and`, `or`, and `not`.

Chapter 4: Loops

4-1. The `while` loop.

4-2. The `for` loop.

4-3. Nested loops.

4-4. Keywords `break` and `continue`.

Chapter 5: Functions

5-1. Function creation (definition).

5-2. Default parameter values.

5-3. Function signature.

5-4. The `return` statement.

5-5. Modules.

5-6. The `import` method.

5-7. The importation method: `from ... import ...`.

5-8. Packages.

5-9. Importing packages.

5-10. Creating one's own packages.

Chapter 6: Lists and Tuples

6-1. List creation and editing.

6-2. List definition and creation.

6-3. Inserting objects into a list.

6-4. Adding an element to the end of a list.

6-5. Inserting an element at a specific position in the list.

6-7. List concatenation.

6-8. Deleting elements from a list.

6-9. The `del` keyword.

6-10. The `remove()` method.

6-11. List traversal (iteration).

6-12. The `enumerate()` function.

6-13. Tuple creation.

Chapter 7: Dictionaries

7-1. Dictionary creation and editing.

7-2. Creating a dictionary.

7-3. Deleting keys from a dictionary.

7-4. Traversal methods.

7-5. Key traversal.

7-6. Value traversal.

7-7. Traversing keys and values simultaneously.

7-8. Dictionaries as function arguments.

Chapter 8: Objects and Classes

8-1. Describing objects and classes, and using classes to model objects.

8-2. Defining classes with data fields and methods.

8-3. Constructing an object using a constructor that invokes the initializer to create and initialize data fields.

Chapter 9: Files

9-1. Relative and absolute paths.

9-2. Reading from and writing to a file.

9-3. Opening a file.

9-4. Closing a file.

9-5. Reading the entire file content.

9-5. Writing to a file.

9-6. Writing other data types.

9-7. The `with` keyword.

9-10. Saving objects to files.

9-11. Serializing an object to a file.

Practical Work (TP):

TP 1: Python Environment Setup (1 Week)

1. Installation of Python and a code editor (VS Code, PyCharm).
2. First steps with the Python interpreter:
    - Executing simple commands in interactive mode.

- Using Python as a calculator.

3. Creating and executing a first Python script.

TP 2: Variables, Data Types, and Operations (1 Week)

1. Manipulation of fundamental data types:
   - Integers, floats, strings, booleans.
   - Type conversion.
2. Arithmetic operations and precedence.

TP 3: Conditional and Iterative Control Structures (1 Week)

1. Conditional instructions (`if`, `elif`, `else`).
2. Loops (`for`, `while`).

TP 4: Functions and Modularity (1 Week)

1. Function definition and calling.
2. Parameters and return values.

TP 5: Data Structures (1 Week)

1. List manipulation.
2. Dictionaries and tuples.
3. Traversal and manipulation of data structures.

TP 6: File Manipulation and Final Project (1 Week)

1. Reading and writing text files.
2. Final project (choice of one):
   - Command-line task manager.
   - Hangman game.
   - Data analysis from a CSV file.
   - Interactive quiz with score saving.

Evaluation method:

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

Bibliographical references:

[1] . Allen B. Downey Think Python: How to Think Like a Computer Scientist, O'Reilly Media, 2015;
[2] . Ramalho, L.. Fluent Python. " O'Reilly Media, Inc.", 2022;
[3] . Swinnen, G.. Apprendre à programmer avec Python 3. Editions Eyrolles, 2012;
[4] . Matthes, E. Python crash course: A hands-on, project-based introduction to programming. no starch press, 2019
[5] . Cyrille, H. (2018). Apprendre à programmer avec Python 3. Eyrolles, 6ème édition. ISBN: 978-2212675214
[6] . Daniel, I. (2024). Apprendre à coder en Python, J'ai lu
[7] . Nicolas, B. (2024). Python, du grand débutant à la programmation objet Cours et exercices corrigés, 3eme édition, Ellipses
[8] . Ludivine, C. (2024). Selenium Maîtrisez vos tests fonctionnels avec Python, Eni

Ressources en ligne :

- Documentation officielle Python : docs.python.org
- Exercices Python sur Codecademy :codecademy.com/learn/learn-python-3
- W3Schools Python Tutorial :w3schools.com/python/

Semester: 3
Teaching Unit: UEM 2.1
Subject 3: Technical Drawing
VHS: 22h30 (Labs: 1h30)
Credits: 2
Coefficient: 1

Subject Content

Chapter 1: General Introduction (2 weeks)

1.1 Purpose of technical drawings and different types of drawings.
1.2 Drawing instruments and materials.
1.3 Standardization (line types, lettering, scale, drawing sheet sizes and folding, title block, etc.).

Chapter 2: Elements of Descriptive Geometry (6 weeks)

2.1 Basic concepts of descriptive geometry.
2.2 Orthogonal projections of a point — projection layout for a point; orthogonal projections of a line (general and special cases) — projection layout for a line — line traces; projections of a plane (general and special positions) — plane traces.
2.3 Views: selection and arrangement of views — dimensioning — slopes and conicity — determining the third view from two given views.
2.4 Drawing execution methods (page layout, 45° line method, etc.).
Exercises and practical evaluation (lab/TP).

Chapter 3: Perspectives (2 weeks)

Different types of perspective (definition and purpose).
Exercises and practical evaluation (lab/TP).

Chapter 4: Sections and Sectional Views (2 weeks)

4.1 Sections: rules for standardized representation (hatching).
4.2 Projections and sections of simple solids (projections and sections of a cylinder, prism, pyramid, cone, sphere, etc.).
4.3 Half-sections, partial sections, broken-out sections, sectional views, etc.
4.4 Technical vocabulary (terminology for machined shapes, profiles, piping, etc.).
Exercises and practical evaluation (lab/TP).

Chapter 5: Dimensioning (2 weeks)

5.1 General principles.
5.2 Dimensioning, tolerances and fits.
Exercises and practical evaluation (lab/TP).

Chapter 6: Introduction to Detail and Assembly Drawings and Parts Lists (1 week)

Exercises and practical evaluation (lab/TP).

Recommendation: A large portion of the practical work (TP) should be assigned as individual take-home exercises.

Assessment method: Continuous assessment: 100%.

Bibliographical references:
(Subject to availability of documentation at the institution, internet resources, etc.)

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

Semester: 3
Teaching Unit: UEM 2.1
Subject 4: Waves and Vibrations Labs
VHS: 22h30 (Labs: 1h30)
Credits: 2
Coefficient: 1

Practical Work Content:

TP.1: Mass–Spring System
TP.2: Simple Pendulum
TP.3: Torsional Pendulum
TP.4: Oscillating Electrical Circuit in Free and Forced Regimes
TP.5: Coupled Pendulums
TP.6: Transverse Oscillations in Vibrating Strings
TP.7: Hoffmann's Groove Pulley (or Hoffmann Pulley)
TP.8: Electromechanical Systems (The electrodynamic loudspeaker)
TP.9: Pohl's Pendulum
TP.10: Propagation of longitudinal waves in a fluid.

Note: It is recommended to select a minimum of 5 practical exercises from the 10 proposed.

Evaluation Method:
Continuous assessment: 100%.

Bibliographical references:
(Subject to availability of documentation at the institution, internet sites, etc.)

Semester: 3
Teaching Unit: UED 2.1
Subject 2: Metrology
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content

Chapter 1: Generalities on Metrology (2 weeks)

1.1 Definition of the different types of metrology (Scientific, also known as laboratory metrology; Legal metrology; Industrial metrology).
1.2 Metrological vocabulary and definitions.
1.3 National and international metrology institutions.

Chapter 2: The International System of Units (SI) (3 weeks)

2.1 Base quantities and their units of measurement.
2.2 Supplementary quantities.
2.3 Derived quantities.

Chapter 3: Metrological Characteristics of Measuring Instruments (6 weeks)

3.1 Error and uncertainty: Accuracy (Justesse), precision, trueness (fidélité), repeatability, reproducibility of a measuring instrument.
3.2 Classification of measurement errors:
3.2.1 Raw value (or observed value).
3.2.2 Systematic error.
3.2.3 Corrected raw value.
3.3 Random errors (Fortuitous errors):
3.3.1 Random errors (stochastic).
3.3.2 Parasitic errors (or spurious errors).
3.3.3 Estimated systematic errors.
3.4 Confidence interval.
3.5 Technical uncertainty.
3.6 Total measurement uncertainty.
3.7 Complete measurement result (statement of result).
3.8 Identification and interpretation of specifications on a definition drawing for the purpose of inspection/control.
3.9 Basic notions on gauges, jigs, and simple measuring instruments.

Chapter 4: Measurement and Inspection (4 weeks)

4.1 Direct measurement of lengths and angles (use of ruler, caliper, micrometer, and protractor).
4.2 Indirect measurement (use of dial indicators/comparators, gauge blocks).
4.3 Dimensional inspection (use of plug gauges, snap gauges, etc.).
4.4 Measurement and inspection machines used in mechanical workshops (use of pneumatic comparators, profile projectors, and roughness testers/stylus profilometers).

Evaluation method:

Final exam: 100%.

Bibliographical references:

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

Semester: 4
Teaching Unit: UEF 2.2.1
Subject 1: Thermodynamics 2
VHS: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Review of Basic Thermodynamics Concepts (1 week)

- Review of the three laws of thermodynamics.

Chapter 2: Thermodynamic Properties of Pure Substances (2 weeks)

- State Diagrams (T-s diagram, p-h diagram, h-s diagram).
- Thermodynamic Tables (Saturation property tables, Superheated vapor property tables).
- Equations of State (Ideal gas equation of state, Virial expansions, Van Der Waals equation, Equations of state derived from the Van Der Waals equation, Reduced variables and Law of Corresponding States, Semi-Empirical Equations of State).

Chapter 3: Thermodynamics of Vapors and Humid Air (2 weeks)

- Thermodynamics of Vapors (Phase change of a pure substance, Calculation of state variables, Vapor quality/dryness fraction, Thermodynamic diagrams and tables).
- Humid Air (Characterization of humid air, Mollier diagram, Elementary operations on humid air).

Chapter 4: Gas Compression (2 weeks)

- Classification of Compression Machinery.
- Isentropic Compression.
- Polytropic Compression.
- Reciprocating Compressors (Piston compressors).
- Rotary Volumetric Compressors (Definitions).

Chapter 5: Gas Expansion (2 weeks)

- Expansion Machines.
- Adiabatic Expansion.
- Non-adiabatic Expansion.
- Work, Efficiency, and Produced Power.
- Rotary Volumetric Compressors (Note: This topic is repeated from Chapter 4, likely intended for application/analysis here).

Chapter 6: Engine Cycles (3 weeks)

- Carnot Cycle.
- Otto Cycle.
- Diesel Cycle.
- Brayton Cycle.
- Steam Turbines.
- Rankine Cycle (Reheat cycle, Regeneration/Extraction cycle, Cogeneration).

Chapter 7: Refrigeration Cycles (3 weeks)

- Gas refrigeration cycle.
- Single-stage vapor compression refrigeration cycle.
- Refrigerants.
- Thermal load calculation for a cold room.
- Two-stage compression cycles.
- Cascade cycles.
- Heat Pumps.

Evaluation Method:

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

References:

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

Semester: 4
Teaching Unit: UEF 2.2.1
Subject 1: Mechanical Manufacturing
VHS: 22h30 (Lectures: 1h30)
Credits: 2
Coefficient: 1

Subject Content:

I — Theory of Metal Cutting

1.1 Cutting materials (1 week)

1.2 Geometry of cutting tools (1 week)

1.3 Chip formation mechanism (1 week)

1.4 Cutting forces (1 week)

1.5 Heating (cutting temperature) (1 week)

1.6 Tool wear and failure (1 week)

1.7 Methodology for selecting cutting parameters (1 week)

II — Machine-Tool Technologies

2.1 Cutting motions (1 week)

2.2 Characterization of a machine tool (main components) (2 weeks)

- Spindle
- Bed
- Guideways/slides

2.3 Kinematic chains (6 weeks)

- Motion transmission mechanisms
- Lathes, shapers and slotters, drilling machines, milling machines, broaching machines, cylindrical and surface grinders, etc.

Assessment method: Final exam: 100%.

Bibliographical references:

1- Techniques de l'ingénieur 2000 B.BM.BT. Janvier 2000 Printed in France by Imprimerie Strasbourgeoise Schiltighein- ISTRAIN

2- Roger Bonetto les ateliers flexibles de production 2ème édition Hermes 1987-Paris

3- G. Levallant ; M.Dessoly ; P.Géodossi ; P.Leroux ; J.C.Moulet ; G.Poulachon ; P.Robert Usinage par enlèvement de copeaux- de la technologie aux applications industrielles Ensam. Edition Eyrolles N° 7211- Juin 2005 Paris

4- Eléments de Fabrication Edition Ellipses. Copyright 1995 Paris

5- Michel Ahby, Choix de Matériaux en Conception Mécanique ; Dunod, 1999

6- Claude Hazard, La Commande Numérique des M O, édition Foucher, Paris 1984

7- Gonzalez, CN par calculateur, édition Foucher Paris 1985.

8- Philippe DEPEYRE, Cours « Fabrication mécanique », Faculté des Sciences et Technologies,
Université de la Réunion, Année 2004-2005

Semester: 4
Teaching Unit: UEF 2.2.1
Subject 1: Complex Analysis
VHS: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Complex Functions and Special Functions

Chapter 1: Holomorphic Functions. Cauchy-Riemann Conditions (3 weeks)

Chapter 2: Power Series (3 weeks)
Convergence radius, convergence domain, power series expansion, analytic functions, Laurent series and expansions.

Chapter 3: Cauchy's Theory (3 weeks)
Cauchy's theorem, Cauchy's formulas, singular points, general method for complex integrals.

Chapter 4: Applications (4 weeks)
Holomorphy-analyticity equivalence, Maximum theorem, Liouville's theorem, Rouché's theorem, Residue theorem, residue method for integrals.

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

Evaluation Method:
Continuous assessment: 40%, Final exam: 60%.

Bibliographic References:

1. Henri Cartan, *Théorie élémentaire des fonctions analytiques d'une ou plusieurs variables complexes* (Hermann, Paris, 1985)
2. Jean Kuntzmann, *Variable complexe* (Hermann, Paris, 1967)
3. Richard Courant, Herbert Robbins, *What is Mathematics?* (Oxford University Press, 1978)
4. Walter Rudin, *Analyse réelle et complexe* (Masson, Paris, 1975)

Semester: 4
Teaching Unit: UEF2.2.2
Subject 1: Numerical Methods
Contact Hours: 67h30 (Lectures: 1h30, Tutorials: 1h30; Labs: 1h30)
Credits: 5
Coefficient: 3

Subject Content:

Numerical Methods

Chapter 1: Solution of Nonlinear Equations f(x) = 0 (3 weeks)

1. Introduction to computational errors and approximations.
2. Overview of methods for solving nonlinear equations.
3. Bisection method.
4. Fixed-point iteration (successive approximations).
5. Newton–Raphson method.

Chapter 2: Polynomial Interpolation (2 weeks)

1. General introduction.
2. Lagrange interpolation polynomial.
3. Newton polynomials (Newton's divided differences form).

Chapter 3: Function Approximation (2 weeks)

1. Least-squares approximation and quadratic mean approximation methods.
2. Orthogonal (or pseudo-orthogonal) systems; approximation by orthogonal polynomials.
3. Trigonometric approximation (Fourier/trigonometric series approximation).

Chapter 4: Numerical Integration (2 weeks)

1. General introduction.
2. Trapezoidal rule.
3. Simpson's rule.
4. Quadrature formulas.

Chapter 5: Numerical Solution of Ordinary Differential Equations (2 weeks)
(Initial-value / Cauchy problems)

1. General introduction.
2. Euler's method.
3. Improved (modified) Euler's method.
4. Runge–Kutta methods.

Chapter 6: Direct Methods for Solving Linear Systems (2 weeks)

1. Introduction and definitions.
2. Gaussian elimination with pivoting.
3. LU factorization.
4. Cholesky factorization (for symmetric positive-definite systems).
5. Thomas algorithm (TDMA) for tridiagonal systems.

Chapter 7: Iterative Methods for Solving Linear Systems (2 weeks)

1. Introduction and definitions.
2. Jacobi method.
3. Gauss–Seidel method.
4. Use of relaxation (Successive Over-Relaxation, SOR).

Subject 3: Numerical Methods Labs

Subject Content:

1. **Solution of Nonlinear Equations**
   1.1. Method of Bisection.
   1.2. Fixed-Point Iteration Method.
   1.3. Newton–Raphson Method.
2. **Interpolation and Approximation**
   2.1. Newton Interpolation (Newton's divided difference formula).
   2.2. Chebyshev Approximation (e.g., using Chebyshev polynomials).
3. **Numerical Integration**
   3.1. Trapezoidal Rule Method.
   3.2. Simpson's Method.
4. **Differential Equations**
   4.1. Runge–Kutta Methods (likely referring to RK4).
5. **Systems of Linear Equations**
   5.1. Gauss–Jordan Elimination Method.
   5.2. Crout Decomposition and LU Factorization.
   5.3. Jacobi Method.
   5.4. Gauss–Seidel Method.

References:

1. Algorithmique et calcul numérique : travaux pratiques résolus et programmation avec les logiciels Scilab et Python / José Ouin, . - Paris : Ellipses, 2013 . - 189 p.

2. Mathématiques avec Scilab : guide de calcul programmation représentations graphiques ; conforme au nouveau programme MPSI / Bouchaib Radi, ; Abdelkhalak El Hami . - Paris : Ellipses, 2015 . - 180 p.

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

Evaluation Method:

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

Références:

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

Semester: 4
Teaching Unit: UEF2.2.3
Subject 1: Strength of Materials 1
Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: INTRODUCTIONS AND GENERALITIES (2 weeks)

1.1 Objectives and assumptions of strength of materials
1.2 Classification of solids (beam, plate, shell)
1.3 Different types of loading
1.4 Supports (fixed, hinged, pinned)
1.5 General equilibrium principle – Equilibrium equations
1.6 Principle of sections – Reduction elements
1.7 Definitions and sign conventions for:

- Normal force N
- Shear force T
- Bending moment M

Chapter 2: TENSION AND COMPRESSION (3 weeks)

2.1 Definitions
2.2 Normal stress in tension and compression
2.3 Elastic deformation in tension/compression
2.4 Strength condition for tension/compression

Chapter 3: SHEAR (2 weeks)

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

Chapter 4: GEOMETRIC CHARACTERISTICS OF CROSS-SECTIONS (3 weeks)

4.1 Static moments of a cross-section
4.2 Moments of inertia of a cross-section
4.3 Transformation formulas for moments of inertia

Chapter 5: TORSION (2 weeks)

5.1 Definitions
5.2 Tangential or shear stress
5.3 Elastic deformation in torsion
5.4 Strength condition for torsion

Chapter 6: SIMPLE PLANE BENDING (3 weeks)

6.1 Definitions and assumptions
6.2 Shear forces, bending moments
6.3 Shear force and bending moment diagrams
6.4 Relationship between bending moment and shear force
6.5 Deflection of a beam under simple bending (deflection)
6.6 Calculation of stresses and sizing

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

Références:

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

Semester: 4
Teaching Unit: UEM2.2
Subject 1: Computer-Aided Drawing
Contact Hours: 22h30 (Labs: 1h30)
Credits: 2
Weighting: 1

Subject Content:

1. PRESENTATION OF THE SELECTED SOFTWARE (4 weeks)
(SolidWorks, AutoCAD, Catia, Inventor, etc.)
1.1 Introduction and history of CAD;
1.2 Configuration of the selected software (interface, shortcuts toolbar, options, etc.);
1.3 Software reference elements (software help, tutorials, etc.);
1.4 File saving (part file, assembly file, drawing file, saving procedure for submission to the teacher);
1.5 Communication and interdependence between files.

2. SKETCH CONCEPTS (3 weeks)
2.1 Sketch tools (point, straight line segment, arc, circle, ellipse, polygon, etc.);
2.2 Sketch relations (horizontal, vertical, equal, parallel, collinear, fixed, etc.);
2.3 Sketch dimensioning and geometric constraints.

3. 3D MODELING (3 weeks)
3.1 Plane concepts (front plane, right plane, top plane);
3.2 Basic functions (extrusion, material removal, revolution);
3.4 Display functions (zoom, multiple views, multiple windows, etc.);
3.5 Modification tools (Delete, Offset, Copy, Mirror, Trim, Extend, Move);
3.6 Creating a section view of the model.

4. 3D MODEL DRAWING (3 weeks)
4.1 Drawing and title block editing;
4.2 View selection and layout;
4.3 Dressings and object properties (hatching, dimensioning, text, tables, etc.)

5. ASSEMBLIES (2 weeks)
5.1 Assembly constraints (parallel, coincident, coaxial, fixed, etc.);
5.2 Creating assembly drawings;
5.3 Assembly drawing layout and parts list;

- Exploded view.

Evaluation Method:
Continuous assessment: 100%.

Références:

- Solidworks bible 2013 Matt Lombard, Edition Wiley,
- Dessin technique, Saint-Laurent, GIESECKE, Frederick E. Éditions du renouveau pédagogique Inc., 1982.

- Exercices de dessins de pièces et d'assemblages mécaniques avec le logiciel SolidWorks, Jean-Louis Berthéol, François Mendes,
- La CAO accessible à tous avec SolidWorks : de la création à la réalisation tome1 Pascal Rétif,
- Guide du dessinateur industriel, Chevalier A, Edition Hachette Technique,

Semester 4 – TP Strength of Materials
VHS: (TP: 1h30) | Credits: - | Coefficient: -

Subject Content:

- **TP .1:** Simple tension-compression tests
- **TP .2:** Torsion test
- **TP .3:** Simple bending test
- **TP .4:** Impact toughness test
- **TP .5:** Hardness test

Evaluation Method: Continuous assessment: 100%.

Semester: 4
Teaching Unit: UEM2.2
Subject 5: TP Mechanical Manufacturing
VHS: 22h30 (TP: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

TP .1: Turning a two-diameter cylindrical part with facing and longitudinal turning operations

- Rough and finished drawing execution
- Cutting speed determination and machining process planning
- Tool, machine, and measurement instrument preparation
- Blank positioning, clamping, machine setup and adjustment
- Operation execution and part completion

TP .2: Milling and drilling of a prismatic part focusing on milling and drilling phases

- Part form, dimensions, tolerances, and surface finish definition (finished drawing)
- Rough drawing
- Cutting speed determination and machining process planning (excluding grinding)
- Blank cutting
- Tool, machine(s), and measurement instrument preparation
- Blank positioning, clamping, machine setup and adjustment
- Operation execution and part completion

TP .3: Surface grinding and surface finish examination (using TP #2 part)

- Analysis of TP .2 rough and finished drawings
- Grinding speed determination and complete machining process planning (including grinding)
- Tool, machine, and surface finish measurement instrument preparation (roughness)
- Blank positioning, clamping, machine setup and adjustment
- Grinding phase execution and surface finish control

TP .4: Welding

- Parts preparation for assembly
- Filler metal selection
- Weld bead execution
- Cleaning and inspection

Evaluation Method: Continuous assessment: 100%.

Semester: 4
Teaching Unit: UEF 2.2.2
Subject 1: Industrial Electricity
VHS: 22h30 (Lectures: 1h30)
Credits: 2
Coefficient: 1

Subject Content:

Chapter 1 – Electrical Circuits (4 weeks)
1.1 Introduction
1.2 Current and voltage in electrical circuits
1.3 Resistors and equivalent circuits
1.4 Work and power
1.5 Single-phase and three-phase electrical circuits
Chapter 2 – Magnetic Circuits (3 weeks)
2.1 Magnetism and electricity
2.2 Fundamental laws
2.3 Materials and magnetic circuits
Chapter 3 – Transformers (2 weeks)
3.1 Description
3.2 Equivalent circuits
3.3 Measurement transformers
3.4 Special transformers
Chapter 4 – Electrical Machines (3 weeks)
4.1 DC machines (shunt, separate, series excitation)
4.2 Synchronous machines
4.3 Asynchronous machines
4.4 Special machines
4.5 Three-phase motor connections
Chapter 5 – Electrical Measurements (3 weeks)
5.1 Measurement in physics
5.2 Measurement quality – errors
5.3 Digital display instrument structure
5.4 Current and voltage measurements
5.5 Power and energy measurements
5.6 Electrical installation wiring diagrams - Wire section calculation
Evaluation Method: Final exam: 100%.
References:

- *Exercices et problèmes d'électrotechniques* by Luc Lasne (Dunod, 2011)
- *Electrotechnique: modélisation et simulation des machines électriques* by Rachid Abdessemed (Ellipse, 2011)
- *Circuits électriques* by Jean-Paul Bancarel (Ellipse, 2001)
- *Analyse des circuits électriques* by Charles K. Alexander & Matthew Sadiku (De Boeck, 2012)

Semester: 4
Teaching Unit: UED2.2
Subject 2: Materials Science
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

Chapter 1: Generalities (3 weeks)

1.1 Material classification:
1.1.1 Metals and alloys
1.1.2 Ceramics and glasses
1.1.3 Polymers
1.1.4 Composite materials
1.2 Application domains
1.3 Material structures: amorphous and crystalline materials
1.4 Crystallography basics

Chapter 2: Equilibrium Diagrams (4 weeks)

2.1 Material crystallization
2.1.1 Crystallization principle and cooling curves
2.1.2 Crystallization of pure metals
2.1.3 Alloy crystallization
2.2 Equilibrium diagram of completely miscible metals
2.3 Equilibrium diagram of partially miscible metals

Chapter 3: Iron-Carbon Equilibrium Diagram (4 weeks)

3.1 Iron and carbon characteristics
3.2 Iron-carbon equilibrium diagram
3.3 Iron-cementite equilibrium diagram
3.4 Standardized designation of steels and cast irons
3.5 Standardized designation of alloy steels

Chapter 4: Heat Treatments and Diffusion Thermochemical Treatments (3 weeks)

1. Heat treatments: Annealing, Quenching, Tempering
2. Thermochemical treatments: Carburizing, Nitriding, Carbonitriding

Evaluation Method: Final exam: 100%.

References:

- *Science et génie des matériaux* by William D. Callister (Dunod)
- *Matériaux T1 & T2* by Michael F. Ashby & David R. H. Jones (Dunod)
- *Des matériaux* by Jean-Marie Dorlot & Jean-Paul Baïlon
- *Structures et matériaux* by James Gordon
-

Semester: 4
Teaching Unit: UET2.2
Subject: Information and Communication Techniques
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

Chapter 1: Information research, analysis, organization (2 weeks)
Chapter 2: Expression capacity improvement (2 weeks)
Chapter 3: Autonomy, organization, project communication (2 weeks)
Chapter 4: ICT definition and evolution (2 weeks)
Chapter 5: Information search, use, recovery (2 weeks)
Chapter 6: ICT rights (2 weeks)
Chapter 7: Sensitive information security, data protection (3 weeks)

Evaluation Method: Final exam: 100%.

Références :

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

Semester: 5
Teaching Unit: UEF 3.1.1
Subject 1: Fluid Mechanics 2
VHS: 67h30 (Lectures: 3h00; Tutorials: 1h30)
Credits: 6
Coefficient: 3

Subject Content:

Chapter 1: Fluid Kinematics (6 weeks)
Reference systems. Continuity equation (differential form). Volumetric and mass flow rates. Rotational and irrotational flows. Circulation and vorticity. Potential flows, planar flows, elementary potential flows. Superposition of simple flows. Graphical superposition method. Elements of complex potential theory. Complex-form elementary potential flows. Conformal mapping method.

Chapter 2: Control Volume Analysis (5 weeks)
2.1 Mass conservation - continuity equation derivation for fixed non-deformable, moving non-deformable, and deformable control volumes.
2.2 Newton's second law - linear momentum equation and moment of momentum equation derivations and applications.

Chapter 3: Dimensional Analysis and Similitude (4 weeks)
Introduction. Dimensional analysis. Similitude. Applications.

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Bibliographic References:

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

Semester: 5
Teaching Unit: UEF 3.1.1
Subject 2: Heat Transfer 1
VHS: 45h00 (Lectures: 1h30; Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Heat Transfer Introduction vs. Thermodynamics (1 week)

Chapter 2: Basic Heat Transfer Laws (2 weeks)

Chapter 3: Heat Conduction (7 weeks)
Fourier's law. Thermal conductivity and typical values for common materials. Factors affecting thermal conductivity. Energy equation, simplifying assumptions, different forms. Spatial and initial boundary conditions. Four linear boundary conditions and practical significance. Analytical solutions in Cartesian, cylindrical, and spherical coordinates. Conductive systems with heat sources. Steady-state electrical analogy. Longitudinal rectangular fin problem: fin equation, solution, efficiency and effectiveness calculations. Generalization to radial fins with uniform profile.

Chapter 4: Convective Heat Transfer (5 weeks)
Convection mechanisms. Convective transfer parameters. Types: forced, natural, mixed convection with examples. Laminar vs. turbulent convection (forced/natural). Solution methods: dimensional analysis/experiments, integral methods for boundary layer approximations, full convection equations, mass transfer analogies. Pi theorem and key dimensionless numbers (Re, Pr, Gr, Ra, Pe, Nu) for forced/natural convection with physical significance.

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Bibliographic References: [Previous context references for heat transfer courses]

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

Semester: 5
Teaching Unit: UEF 3.1.2
Subject 1: Turbomachines 1
VHS: 45h00 (Lectures: 1h30; Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Turbomachine Definitions and General Theory (4 weeks)
Turbomachine classification, general theory, Euler's theorem. Velocity diagrams. Head, power. Turbomachine efficiency. Energy transfer components. Degree of reaction, load variation.

Chapter 2: Pumps (3 weeks)
General relationships. Centrifugal and axial pumps. Descriptions, velocity triangles, efficiencies.

Chapter 3: Similarity in Turbomachines (3 weeks)
General relationships. Rateau invariants. Other coefficients. Similar operating machines. Generalization. Specific speed.

Chapter 4: Cavitation in Pumps (2 weeks)
Origin and cavitation criteria. Manifestations. Influence of various factors. Cavitation similarity.

Chapter 5: Hydraulic Turbines (3 weeks)
Pelton turbine, reaction turbine, Francis turbine, Kaplan turbine.

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Références :

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

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

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

Teaching Unit: UEF 3.1.2
Subject 2: Energy Conversion
VHS: 45h00 (Lectures: 1h30; Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Single-Phase Power Cycles (4 weeks)
Definitions. Carnot, Otto, Diesel, mixed, Joule-Brayton, Ericsson, Stirling cycles. Preheat/regenerator cycles. Multi-stage cycles with regenerator, intermediate cooling/reheating. Gas thermal power plant components.

Chapter 2: Two-Phase Power Cycles (4 weeks)
Phase change review. Rankine, Hirn, reheat, extraction cycles. Mixed gas-vapor cycles. Steam thermal plants. Hybrid solar-gas plants. Cogeneration. Nuclear power plant concepts.

Chapter 3: Exergy and Exergetic Analysis (3 weeks)
Applications to gas and steam thermal power plants.

Chapter 4: Combustion Thermodynamics (3 weeks)
Mixture properties, stoichiometric combustion, heat of formation, calorific values, adiabatic flame temperature. Chemical kinetics: elementary reactions, chain reactions, free radicals, recombinations, equilibrium constants, reaction rates. Simplified combustion models, pressure dependence, partial equilibrium, quasi-steady states. Autoignition, spontaneous ignition, pressure effects on autoignition temperature, controlled ignition, critical heat flux for ignition.

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Références:

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

Semester: 5
Teaching Unit: UEM 3.1
Subject 1: TP Heat Transfer
VHS: 22h30 (TP: 1h30)
Credits: 2
Coefficient: 1

Subject Content:
Plan experiments related to heat transfer based on available equipment.

Evaluation Method:
Continuous assessment: 100%.

Subject 2: TP Turbomachines 1
VHS: 22h30 (TP: 1h30)
Credits: 2
Coefficient: 1

Subject Content:

Plan experiments related to turbomachines based on available equipment.

Evaluation Method:

Continuous assessment: 100%.

Semester: 5
Teaching Unit: UEM 3.1
Subject 3: TP Energy Conversion
VHS: 22h30 (TP: 1h30)
Credits: 2
Coefficient: 1

Subject Content:
Plan experiments related to energy conversion based on available equipment.

Evaluation Method:
Continuous assessment: 100%.

Semester: 5
Teaching Unit: UEM 3.1
Subject 4: Measurement and Instrumentation
VHS: 37h30 (Lectures: 1h30; TP: 1h30)
Credits: 3
Coefficient: 2

Subject Content:

Chapter 1: Thickness and Length Measurements (5 weeks)
Mechanical, pneumatic, and optical instruments. Error assessment.

Chapter 2: Temperature Measurements (5 weeks)
Thermocouples, thermistors, infrared detectors, pyrometers. Thermal sensor calibration. Thermal sensor errors. Sensor selection. Automatic data acquisition and acquisition cards.

Chapter 3: Flow, Velocity, and Pressure Measurements (5 weeks)
Flowmeters (types, selection, errors). Pitot tubes, Prandtl probes. Hot-wire/hot-film anemometers, laser Doppler anemometers, PIV. Pressure measurements: mechanical, piezoelectric sensors. Electrical measurements, signal processing, result interpretation, experiment setup.

Practical Work:
Minimum 5 TPs based on available equipment and facilities.

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Bibliographic References:

1. R.J. Goldstein, *Fluid Mechanics Measurements*, 1983.
2. J.O. Hinze, *Turbulence*, McGraw-Hill, 1975.
3. C.G. Lomas, *Fundamentals of hot wire anemometry*, Cambridge Univ. Press, 1986.
4. E. Guyon et al., *Hydrodynamique physique*, CNRS Ed., 2001.

Semester: 5
Teaching Unit: UED 3.1
Subject 1: Machine Elements Concepts
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

Chapter 1: Introduction (2 weeks)

Mechanical construction overview, design study, safety factor, standards, economy, reliability.

Chapter 2: Threaded Assemblies (3 weeks)

Screws, bolts, studs. Strength calculations (shear, crushing, bending, hyperstatic system preloading).

Chapter 3: Gears (3 weeks)

Cylindrical gears (straight and helical teeth), bevel gears (straight and helical teeth), worm gears.

Chapter 4: Shafts and Axles (2 weeks)

Preliminary diameter calculation, fatigue verification for shafts and axles.

Chapter 5: Motion Transmission (calculation and sizing) (3 weeks)

Plain bearings and thrust bearings, rolling bearings, friction wheels, belts, chains.

Chapter 6: Couplings, Clutches, and Brakes (2 weeks)

Evaluation Method:

Exam: 100%.

Références :

1. B. J. Morvan, « Les engrenages », Ed. : Delcourt G. Productions, 01/2004.
2. G. Henriot, "Lesengrenages", Ed. :Dunod
3. A. Pouget , T. Berthomieu , Y. Boutron, E. Cuenot, « Structures et mécanismes - Activités de construction mécanique », Ed. Hachette Technique.
4. R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu. « Précis de Construction Mécanique », Tome 1, Projets-études, composants, normalisation, AFNOR, NATHAN, 2001.
5. R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu, « Précis de Construction Mécanique », Tome 3, Projets-calculs, dimensionnement, normalisation, AFNOR, NATHAN, 1997.
6. Y. Xiong, Y. Qian, Z. Xiong, D. Picard, « Formulaire de mécanique », Pièces de construction, EYROLLES, 2007.
7. J. L. FANCHON, « Guide de Mécanique », NATHAN, 2008.
8. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 1, Principes et Eco-conception, DUNOD, 2009.
9. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 2, Applications, DUNOD, 2001.
10. F. ESNAULT, « Construction mécanique », Transmission de puissance, Tome 3, Transmission de puissance par liens flexibles, DUNOD, 1999.
11. Bawin, V. et Delforge, C., « Construction mécanique », Edition originale : G. Thome, Liège, 1986.
12. M. Szwarcman, « Eléments de machines », édition Lavoisier, 1983.
13. W. L. Cleghorn, "Mechanics of machines", Oxford University Press, 2008.

Semester: 5
Subject 2: Regulation and Control
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

Chapter 1: Control System Terminology (1 week)
Servosystem functional diagram, constitutive elements of servosystem diagrams.

Chapter 2: Laplace Transform (2 weeks)
Definitions and properties.

Chapter 3: Transfer Functions (2 weeks)
Functional diagram algebra and system transfer functions.

Chapter 4: First-Order Servosystem Study (3 weeks)
Definition and transfer function, system response to various input signals.

Chapter 5: Second-Order Servosystem Study (3 weeks)
Definition and transfer function, system response to various input signals, complex plane representation.

Chapter 6: Bode and Nyquist Diagrams of Servosystems (2 weeks)

Chapter 7: Servosystem Stability Study (2 weeks)
Analytical stability criteria (Routh, Hurwitz), geometric criterion (Nyquist).

Evaluation Method:
Exam: 100%.

Références :

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

Semester: 5
Teaching Unit: UET 3.1
Subject 1: Environment and Sustainable Development
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

Chapter 1: Environment Concept Introduction (2 weeks)
Environment definition (general, legal). Brief history. Human-environment interaction. Human environmental modification. Demographics as scapegoat.

Chapter 2: Sustainable Development Concept (2 weeks)
Definition, history, fundamental principles (ethics, precaution, prevention). Sustainable development goals. Environmental challenges.

Chapter 3: Environment and Natural Resources (4 weeks)
Resources overview: water, air, fossil fuels (oil, natural gas, coal), renewables (solar, wind, hydro, geothermal, biomass), minerals, biodiversity, soils, food resources.

Chapter 4: Pollutants (4 weeks)
Pollutant types, regulated pollutants, organic compounds, heavy metals, particles, CFCs. Environmental effects: greenhouse effect/climate change, ozone depletion, acidification, eutrophication, photochemistry, acid rain, ozone peaks. Material/ecosystem/health impacts. CORINAIR nomenclature.

Chapter 5: Environmental Preservation (3 weeks)
New materials, oil reservation for noble uses, energy efficiency improvement, recycling. Economic/legal/regulatory preservation mechanisms. Public authority role. Private solutions. Current environmental policies. Polluter-pays principle. Ecological taxation, emission permits markets.

Evaluation Method:
Exam: 100%.

Références :

1- De Jouvenel, B., « Le thème de l'environnement, Analyse et prévision », 10, pp. 517533, 1970.
2- Faucheux S., Noël J-F, « Economie des ressources naturelles et de l'environnement » , Armand Collin, Paris.
3- Reed D. (Ed.), « Ajustement structurel, environnement et développement durable », l'Harmattan, Paris, 1995.
4- Vivien F-.D, « Histoire d'un mot, histoire d'une idée : le développement durable à l'épreuve du temps », Ed. scientifiques et médicales Elsevier ASA, pp. 19-60, 2001.
5- Boutaud, Aurélien, Gondran, Natasha, « L'empreinte écologique », Paris : La Découverte, 2009.
6- Lazzeri, Yvette (Dir.), « préface de Gérard Guillaumin, Développement durable, entreprises et territoires: vers un renouveau des pratiques et des outils », Paris, L'Harmattan, 2008.

Semester: 6
Teaching Unit: UEF 3.2.1
Subject 1: Turbomachines 2
VHS: 67h30 (Lectures: 3h00; Tutorials: 1h30)
Credits: 6
Coefficient: 3

Subject Content:

Chapter 1: Axial Turbine Presentation (1 week)
Lifting surface aerodynamics, lift and drag, angle of losses.

Chapter 2: Static and Total Thermodynamic Quantities (1 week)
Total state definition, graphical representation on (h,s) diagram.

Chapter 3: General Turbomachine Equations (3 weeks)
Total enthalpy conservation in stationary channels, rothalpy conservation in rotating channels.

Chapter 4: Nozzle Study (simple nozzle and Laval nozzle) (3 weeks)
Operating regimes (subsonic, sonic, supersonic), sonic choking, normal shock waves.

Chapter 5: Single-Stage Impulse Turbine Theory (1 week)
Principle and definition, mass-specific work expressions, velocity triangles, stationary/rotating channel roles, real operation thermodynamic representation on (h,s) diagram, stator losses, rotor losses, exit loss, available drop concept, aerodynamic efficiency.

Chapter 6: Curtis Wheel Study. Multicellular Turbines - Reaction Turbines (1 week)
Principle and definition, real operation representation on (h,s) diagram, aerodynamic efficiency.

Chapter 7: Compressors (3 weeks)
Velocity triangles, thermodynamic evolution in compression machines, mass-specific work and power calculations, efficiencies, compressor surge phenomenon.

Chapter 8: Fans (2 weeks)
Turbomachine role in industrial installations, technological aspects.

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Références bibliographiques:

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

Semester: 6
Teaching Unit: UEF 3.2.1
Subject 2: Internal Combustion Engines
VHS: 45h00 (Lectures: 1h30; Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Generalities (2 weeks)
Thermal engine operating principle and classification. Internal combustion engine fuels.

Chapter 2: Engine Cycle Thermodynamics (4 weeks)
Beau de Rochas cycle, Diesel cycle, Sabathé cycle. Real cycles and efficiencies. Energy balance. Gasoline engine fuel supply, ignition systems, combustion.

Chapter 3: Real Internal Combustion Engine Cycle (4 weeks)
Intake, compression, combustion, expansion, exhaust. Indicated parameters, effective parameters. Theoretical indicated diagram construction.

Chapter 4: Reciprocating Engine Dynamics (3 weeks)
Crank-connecting rod system: kinematic and dynamic study. Valve train system: kinematic and dynamic study. Balancing.

Chapter 5: Reciprocating Engine Performance and Characteristics (2 weeks)
Performance parameters, standards, characteristics (full load, partial loads, universal).

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Références bibliographiques:

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

Teaching Unit: UEF 3.2.2
Subject 1: Refrigeration Machines and Heat Pumps
VHS: 45h00 (Lectures: 1h30; Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Generalities (2 weeks)
Refrigeration history, Carnot refrigeration cycle, Carnot cycle coefficient of performance.

Chapter 2: Vapor Compression Refrigeration Cycle Thermodynamics (4 weeks)
Basic thermodynamic cycle representation (T-s, P-h diagrams). Practical cycle representation. Thermal balance. Refrigerant fluids. Performance study (COP). Industrial refrigeration applications.

Chapter 3: Vapor Compression Refrigeration Machine Components (3 weeks)
Compressors, evaporators, condensers, expansion devices.

Chapter 4: Other Refrigeration Machine Types (3 weeks)
Absorption refrigeration machine operating principle, air refrigeration cycle.

Chapter 5: Heat Pump Thermodynamic Cycle (3 weeks)
Fluid schematic, cycle reversal valve, performance study (summer/winter seasons). Heat pump types (geothermal, etc.).

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Références bibliographiques:

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

Semester: 6
Teaching Unit: UEF 3.2.2
Subject 2: Heat Transfer 2
VHS: 45h00 (Lectures: 1h30; Tutorials: 1h30)
Credits: 4
Coefficient: 2

Subject Content:

Chapter 1: Continuation of Semester 1 Convection Heat Transfer (5 weeks)
Boundary layer approximate solutions: integral methods. Complete treatment of forced convection on horizontal flat plate and natural convection on vertical flat plate. Derive Nu=f(Re,Pr) and Nu=f(Gr,Pr) relations. Exact solutions for laminar forced convection on horizontal plate and natural convection on vertical plate. Compare exact vs. approximate analyses. Laminar convection in cylinders: assumptions, problem solution, Nusselt number derivation for imposed temperature and heat flux.

Chapter 2: Radiative Heat Transfer (6 weeks)
Introduction: solid angle concepts. Surface/volume radiative transfer mechanisms. Definitions (luminance, illuminance, intensity, emissivity). Bouguer formula, Kirchhoff/Drappir laws. Blackbody radiation: Planck's law, spectral emission, Stefan-Boltzmann law. Surface radiative properties. Radiation between infinite parallel planes (transparent medium), radiation shields. Radiation between concave black surfaces: view factors, reciprocity, summation, superposition, symmetry rules. Crossed-string method for infinitely long surfaces. Concave surface radiation loss. Radiation between n arbitrary surfaces forming enclosure: enclosure rules, radiosity-irradiation method, electrical analogy. Radiation through semi-transparent medium (emitting/absorbing): simplified method, Hottel spherical cap, gas mixture emissivities/absorptivities.

Chapter 3: Heat Exchangers and Boilers (4 weeks)
Heat exchanger concepts: classification, types, industrial uses, temperature profiles, heat flux, overall heat transfer coefficient. Calculation methods: LMTD method, NTU method, comparison. Boilers: types, loss analysis, efficiency.

Evaluation Method:
Continuous assessment: 40%; Exam: 60%.

Références bibliographiques:

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

12. J. Taine, J. P. Petit, « Transfert de chaleur et mécanique des fluides anisothermes », Dunod, 1988.
13. M. F. Modest. “Radiative Heat Transfer”, New York: McGraw-Hill, 2014.
14. R. Siegel and J. R. Howell, “Thermal Radiation Heat Transfer”, 3rd ed. Washington, D.C.: Hemisphere, 2003.
15. N. V. Suryanaraya, “Engineering Heat Transfer”, St. Paul, Minn.: West, 1995.
16. H. D. Baehr and K. Stephan, “Heat and Mass transfer”, 2nd revised edition, Springer Verlag.

Semester: 6
Teaching Unit: UEM 3.2
Subject 1: End-of-Cycle Project
VHS: 45h00 (TP: 3h00)
Credits: 4
Coefficient: 2

Subject Content:
End-of-cycle project theme selected jointly by supervising teacher and student(s) (individual, pair, or trio). Theme must align with training objectives, student License-level skills, and local socio-economic context. Project may be subdivided if needed.

Key Project Phases:

- **Initial Phase:** Literature review, software/hardware sourcing, relevant course review. Teacher reinforces "Report Writing Methodology" and "Presentation Methodology" from common core semesters.
- **Final Deliverables:** Detailed written report covering: theme presentation with socio-economic relevance; methods/tools/references/professional contacts used; results analysis vs. objectives; discrepancy critique; difficulties encountered with work limitations and follow-up suggestions.
- **Oral Presentation:** Student(s) present work (oral report or poster) to supervising teacher and examiner, who evaluate technical content and presentation quality through questions.

Evaluation Method:
Continuous assessment: 100%.

Semester: 6
Teaching Unit: UEM 3.2Subject 2: Refrigeration Machines and Heat Pumps Labs
VHS: 22h30 (Labs: 1h30)
Credits: 2
Coefficient: 1

Subject Content:

Plan experiments related to refrigeration machines and heat pumps based on available equipment.

Evaluation Method:

Continuous assessment: 100%.

Semester: 6
Subject 3: Internal Combustion Engines Labs
VHS: 15h00 (Labs: 1h00)
Credits: 1
Coefficient: 1

Subject Content:
Plan experiments related to internal combustion engines based on available equipment.

Evaluation Method:
Continuous assessment: 100%.

Semester: 6
Subject 4: Regulation and Control Labs
VHS: 22h30 (Labs: 1h30)
Credits: 2
Coefficient: 1

Subject Content:
Plan experiments related to regulation and control.

Evaluation Method:
Continuous assessment: 100%.

Semester: 6
Teaching Unit: UED 3.2
Subject 1: Renewable Energies
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

Chapter 1: Solar Astronomy (2 weeks)

Chapter 2: Algerian Solar Potential (2 weeks)
Chapter 3: Thermal Conversion of Solar Energy (4 weeks)
- Flat-plate solar collectors
- Solar concentration: cylindrical, cylindro-parabolic/paraboloid, heliostats
- Thermal solar conversion applications
- Solar heat storage

Chapter 4: Photovoltaic Conversion (3 weeks)
- Physics of photovoltaic cells
- Types of direct conversion cells
- Use of direct conversion panels and service delivery concept

Chapter 5: Wind Energy (2 weeks)
- Wind potential
- Types of wind turbines
- Wind turbine applications

Chapter 6: Geothermal Energy (1 week)
- Geothermal resources in Algeria and utilization

Chapter 7: Biomass (1 week)
- Biomass: waste utilization

Evaluation Method:
Final exam: 100%.
References:

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

Semestre: 6
Unité d'enseignement: UED 3.2
Matière 2: Cryogénie
VHS: 22h30 (Cours: 1h30)
Crédits: 1
Coefficient: 1

Contenu de la matière :

Chapitre 1. Rappels thermodynamiques **(1 Semaine)**

Chapitre 2. Cycles a gaz (Brayton) - étude du turboréacteur (2 Semaines)

Chapitre 3. Cycles à changement de phase (Rankine) **(2 Semaines)**
Etude des cycles de turbine à vapeur à compression et détente.

Chapitre 4. Principales méthodes industrielles d'obtention des basses températures (3 Semaines)
Chapitre 5. Cycles idéaux de liquéfaction et travail minimal(3 Semaines)

Chapitre 6. Cycles réels de liquéfaction(2 Semaines)

Chapitre 7. Séparation des gaz **(2 Semaines)**
Aspects descriptifs de quelques procèdes d'obtention des gaz industriels.

Mode d'évaluation:
Examen: 100%.

Semester: 6
Teaching Unit: UED 3.2
Subject 2: Cryogenics
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

Chapter 1: Thermodynamic Review (1 week)

Chapter 2: Gas Cycles (Brayton) - Turbojet Study (2 weeks)

Chapter 3: Phase Change Cycles (Rankine) (2 weeks)
Study of steam turbine cycles with compression and expansion.

Chapter 4: Main Industrial Methods for Low Temperatures (3 weeks)

Chapter 5: Ideal Liquefaction Cycles and Minimum Work (3 weeks)

Chapter 6: Real Liquefaction Cycles (2 weeks)

Chapter 7: Gas Separation (2 weeks)
Descriptive aspects of industrial gas production processes.

Evaluation Method:
Final exam: 100%.

References:
R.B. Scott, "Cryogenic engineering", Van Nostrand, Princeton, 1959.

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

Semester: 6
Teaching Unit: UET 3.2
Subject: Entrepreneurship and Startups
VHS: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Subject Content:

Chapter 1: Operational Job Preparation (2 weeks)
CV and cover letter writing, job interviews, career research in the field, professional interviews, mock hiring simulations.

Chapter 2: Entrepreneurship and Entrepreneurial Spirit (2 weeks)
Entrepreneurship basics, local companies, entrepreneurial motivation, goal setting, risk-taking.

Chapter 3: Entrepreneur Profile and Role (3 weeks)
Entrepreneur qualities, negotiation skills, active listening, SMEs/TPES role in Algeria, key success factors for TPE/SME creation.

Chapter 4: Finding Good Business Ideas (2 weeks)
Creativity and innovation, recognizing and evaluating business opportunities.

Chapter 5: Launching and Operating a Company (3 weeks)
Market selection, business location, legal structures, funding sources, staff recruitment, supplier selection.

Chapter 6: Business Project Development (3 weeks)
Business Model and Business Plan, creating projects with Business Model Canvas.

Evaluation Method:
Final exam: 100%.

Références :

- FayolleAlain, 2017. Entrepreneuriat théories et pratiques, applications pour apprendre à entreprendre.Dunod, 3e éd.
- LégerJarniou, Catherine, 2013, Le grand livre de l'entrepreneur. Dunod, 2013.
- PlaneJean-Michel, 2016, Management des organisations théories, concepts, performances. Dunod, 4ème éd.
- LégerJarniou, Catherine, 2017, Construire son Business Plan. Le grand livre de l'entrepreneur. Dunod,.
- Sion Michel, 2016, Réussir son business Méthodes, outils et astuces plan.Dunod ,4èmeéd.
- Patrick Koenblit, Carole Nicolas, Hélène Lehongre, Construire son projet professionnel, ESF, Editeur 2011.
- Lucie Beauchesne, Anne Riberolles, Bâtir son projet professionnel, L'Etudiant 2002.
- ALBAGLI Claude et HENAULT Georges (1996), La création d'entreprise en Afrique, ed EDICEF/AUPELF ,208 p.