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

اللجنة البيداغوجية الوطنية
لميدان العلوم و التكنولوجيا
National Pedagogical Committee for the Science and Technology Sector

TRAINING OFFER
STATE ENGINEER

Specifically for TM baccalaureate holders

Updated 2025

Establishment	Faculty / Institute	Department

Domain	Sector	Specialty
Science and technology	**Mechanical Engineering**	***Mechanical Manufacturing and Maintenance***

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عرض تكوين
مهندس دولة

The institution	الكلية/ المعهد	القسم

الميدان	الفرع	التخصص
علوم وتكنولوجيا	هندسة ميكانيكية	التصنيع الميكانيكي والصيانة

Semester-based course organization sheets for the specialty

semester	Teaching unit	Subject Titles	code	Credits	Coefficients	Weekly Hourly Volume			VHS		
						Course	TD	TP		Continuous assessment	Final exam
5	Fundamental EU Code: UEF 5.1 Credits: 8 Coefficients: 4	Mechanical Construction 1	IGMF5.1	4	2	1h30	1h30		45h00	40%	60%
		Analytical Mechanics	IGMF5.2	4	2	1h30	1h30		45h00	40%	60%
	Fundamental EU Code: UEF 5.2 Credits: 16 Coefficients: 9	Fracture mechanics and fatigue	IGMF5.3	4	2	1h30	1h30		45h00	40%	60%
		Crystallography	IGMF5.4	5	3	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
		Non-metallic materials	IGMF5.5	2	1	1h30			22h30		100%
		Automation of industrial systems	IGMF5.6	5	3	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
	Methodological Unit Code: UEM 5.1 Credits: 4 Coefficients: 4	Tutored Project 1	IGMF6.7	2	2		3h00		45h00	100%	
		Maintenance organization and methods	IGMF5.8	1	1	1h30			22h30		100%
		Preventive Maintenance	IGMF5.9	1	1	1h30			22h30		100%
	EU Discovery Code: UED 5.1 Credits: 1 Coefficients: 1	Recycling and waste recovery	IGMF5.10	1	1	1h30			22h30		100%
	EU Transversal Code: UET 5.1 Credits: 1 Coefficients: 1	Technical English related to the specialty	IGMF5.11	1	1	1h30			22h30		100%
Total Hourly Volume of semester 5				**30**	**19**	**15h00**	**10h30**	**3h00**	**427h30**		

semester	Teaching unit	Subject Titles	Code	Credits	Coefficients	Weekly Hourly Volume			VHS	Evaluation method	
						Course	TD	TP		Continuous assessment	Final exam
6	Fundamental EU Code: UEF 6.1 Credits: 12 Coefficients: 7	Mechanical Engineering 2	IGMF6.1	**4**	**2**	1h30	1h30		45h00	40%	60%
		Rheology of materials	IGMF6.2	**5**	**3**	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
		Thermal treatment	IGMF6.3	**3**	**2**	1h30		1h30	45h00	40%	60%
	Fundamental EU Code: UEF 6.2 Credits: 13 Coefficients: 7	Structural Dynamics	IGMF6.4	**4**	**2**	1h30	1h30		45h00	40%	60%
		Mechanism Theory	IGMF6.5	**4**	**2**	1h30	1h30		45h00	40%	60%
		Internal combustion engine	IGMF6.6	**5**	**3**	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
	Methodological Unit Code: UEM 6.1 Credits: 2 Coefficients: 2	Company Internship 1	IGMF6.7	1	1	Hourly volume outside quota (On average 100 hours) Tutoring: 1.5 hours of weekly practical work				100%	
		Troubleshooting and fault management	IGMF6.8	1	1	1h30			22h30		100%
	EU Discovery Code: UED 6.1 Credits: 1 Coefficients: 1	Logistics and inventory management	IGMF6.9	1	1	1h30			22h30		100%
	EU Transversal Code: UET 6.1 Credits: 2 Coefficients: 2	Entrepreneurship and start-up	IGMF6.10	1	1	1h30			22h30		100%
		Introduction to Industrial Property	IGMF6.11	1	1	1h30			22h30		100%
Total Hourly Volume of semester 6				**30**	**19**	**15h00**	**7h30**	**4h30**	**405h00**		

semester	Teaching unit	Subject Titles	Code	Credits	Coefficients	Weekly Hourly Volume			VHS	Evaluation method	
						Course	TD	TP		Continuous assessment	Final exam
7	Fundamental EU Code: UEF 7.1 Credits: 9 Coefficients: 5	Finite element method	IGMF7.1	5	3	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
		Elasticity	IGMF7.2	4	2	1h30	1h30		45h00	40%	60%
	Fundamental EU Code: UEF 7.2 Credits: 12 Coefficients: 7	Metal cutting 1	IGMF7.3	3	2	1h30	1h30		45h00	40%	60%
		Shaping processes	IGMF7.4	4	2	1h30	1h30		45h00	40%	60%
		Mechanical Manufacturing	IGMF7.5	5	3	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
	Methodological Unit Code: UEM 7.1 Credits: 8 Coefficients: 6	Advanced Python Programming		2	2	1h30	-	1h30	45h00	40%	60%
		Personal Professional Project	IGME7.6	2	1	Hourly volume outside quota (On average 100 hours) Tutoring: 1.5 hours of weekly practical work				100%	
		Measurement technique	IGMF7.8	2	1	1h30		1h30	45h00	40%	60%
		Defect detection techniques	IGMF7.6	2	2	1h30		1h30	45h00	40%	60%
	EU Transversal Code: UET 7.1 Credits: 1 Coefficients: 1	HSI in Mechanical Manufacturing	IGMF7.10	1	1	1h30			22h30		100%
Total Hourly Volume of semester 7				**30**	**19**	**13h30**	**7h30**	**7h30**	**427h30**		

semester	Teaching unit	Subject Titles	Code	Credits	Coefficients	Weekly Hourly Volume			VHS	Evaluation method	
						Course	TD	TP		Continuous assessment	Final exam
8	Fundamental EU Code: UEF 8.1 Credits: 10 Coefficients: 6	Machine Tool Components	IGMF8.1	7	4	1h30	3h00	1h30	90h00	(20% Tutorials + 20% Practical Work)	60%
		Metal cutting 2	IGMF8.2	3	2	1h30	1h30		45h00	40%	60%
	Fundamental EU Code: UEF 8.2 Credits: 14 Coefficients: 8	Welding Techniques	IGMF8.3	5	3	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
		Surface corrosion and protection	IGMF8.4	5	3	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
		Hydraulic and pneumatic systems and devices	IGMF8.5	4	2	1h30	1h30	-	45h00	40%	60%
	Methodological Unit Code: UEM 8.1 Credits: 3 Coefficients: 2	Mechanical Properties of Materials	IGMF8.6	2	1	1h30		1h30	45h00	40%	60%
		Company Internship 2	IGMF8.7	1	1	Hourly volume outside quota (On average 100 hours) Tutoring: 1.5 hours of weekly practical work				100%	
	EU Transversal Code: UET 8.1 Credits: 3 Coefficients: 3	Elements of AI applied to mechanical engineering		**2**	**2**	1h30	1h30		45h00	40%	60%
		Adherence to ethical standards and rules of integrity	IGMF8.9	1	1	1h30			22h30		100%
Total Hourly Volume of semester 8				**30**	**19**	**12h00**	**10h30**	**6h00**	**427h30**		

Semester	Teaching unit	Subject Titles	Code	Credits	Coefficients	Weekly Hourly Volume			VHS	Evaluation method	
						Course	TD	TP		Continuous assessment	Final exam
9	Fundamental EU Code: UEF 9.1 Credits: 13 Coefficients: 7	Advanced Structural Dynamics	IGMF9.1	4	2	1h30	1h30		45h00	40%	60%
		High-speed machining	IGMF9.2	5	3	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
		Equipment installation	IGMF9.3	4	2	1h30	1h30		45h00	40%	60%
	Fundamental EU Code: UEF 9.2 Credits: 11 Coefficients: 6	Dynamics of rotating machines	IGMF9.4	4	2	1h30	1h30		45h00	40%	60%
		Tribology and lubrication of mechanical systems	IGMF9.5	5	3	1h30	1h30	1h30	67h30	(20% Tutorials + 20% Practical Work)	60%
		Industrial robotics	IGMF9.6	2	1	1h30			22h30		100%
	Methodological Unit Code: UEM 9.1 Credits: 3 Coefficients: 3	Methods Office	IGMF8.7	1	1	1h30	1h30		45h00	40%	60%
		Industrial Computing (CMMS)	IGMF9.8	2	2	1h30		1h30	45h00	40%	60%
	EU Transversal Code: UET 9.1 Credits: 3 Coefficients: 3	Documentary research and dissertation design	IGMF9.9	1	1	1h30			22h30		100%
		Reverse engineering	IGMF9.10	2	2	1h30	1h30 practical		45h00		60%
Total Hourly Volume of semester 9				**30**	**19**	**15h00**	**9h00**	**6h00**	**450h00**		

Semester 10	Teaching unit	Subject Titles	Code	Credits	Coefficients	Weekly Hourly Volume	VHS	Evaluation method	
						Course, Tutorials, Practical Sessions		Continuous assessment	Final exam
	Fundamental EU Code: UEF 10.1 Credits: 30 Coefficients: 19	Final Year Project	IGMF10.1	**30**	**19**	**28h30**	**427h30**		100%
		Total Hourly Volume							

- Detailed program by subject for semester 1

Semester 1
Teaching Unit: UEF 1.1
Subject 1: Analysis 1
VHS: 67h30 (Course: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Teaching objectives:

The aim of this course is to bridge the gap between the analysis knowledge acquired in high school and the foundations that will form one of the pillars of the mathematical analysis training at the undergraduate level. Given that admission to the first year of analysis will be limited to holders of a technical mathematics baccalaureate, it seems wise to begin by reviewing the basic concepts that will be used throughout this course, so as not to leave anyone behind.

Recommended prior knowledge
Elementary Mathematics at the High School Level

Content of the material:

Chapter 1: Properties of the set R **(3 weeks)**

1. Part that is upper, lower, and bounded.
2. Maximum element, minimum element.
3. Upper limit, lower limit.
4. Absolute value, integer part.

Chapter 2: Real Numerical Sequences **(4 weeks)**

1. Convergent sequences.
2. Comparison theorems.
3. Monotone convergence theorem.
4. Extracted sequences.
5. Adjacent suites.
6. Special sequences (arithmetic, geometric, recurrent)

Chapter 3: Functions of a real variable **(4 weeks)**

1. Definitions (monotony, parity, periodicity)
2. Limitations:
3. Continuity
4. Differentiability

Chapter 4: Common Functions **(4 weeks)**

1. Inverse circular functions.
2. Hyperbolic functions.
3. Inverse hyperbolic functions.

Evaluation method:
Written tests, homework assignments, final exam

Bibliographical references

1- F. Ayres Jr, Theory and Applications of Differential and Integral Calculus - 1175 solved exercises, McGraw-Hill.
2- F. Ayres Jr, Theory and Applications of Differential Equations - 560 Solved Exercises, McGraw-Hill.
3- J. Lelong-Ferrand, JM Arnaudiès, Mathematics Course - Differential Equations, Multiple Integrals, Volume 4, Dunod University.
4- M. Krasnov, Collection of Problems on Ordinary Differential Equations, Moscow Edition
5- N. Piskunov, Differential and Integral Calculus, Volume 1, Moscow Edition
6- J. Quinet, Elementary Course of Higher Mathematics 3- Integral Calculus and Series, Dunod.
7- J. Quinet, Elementary Course of Higher Mathematics 4- Differential Equations, Dunod.
8- J. Quinet, Elementary Course of Higher Mathematics 2- Usual Functions, Dunod.
9- J. Quinet, Elementary Course of Higher Mathematics 1- Algebra, Dunod.
10- J. Rivaud, Algebra: Preparatory Classes and University Volume 1, Exercises with solutions, Vuibert.

Semester 1
Teaching Unit: UEF 1.1
Subject 2: Algebra 1
VHS: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

-To ensure a gradual transition to higher education, taking into account the high school programs, whose acquired knowledge it consolidates and expands;
- To consolidate students' training in the areas of logic, reasoning and calculation techniques which are essential tools for both mathematics and scientific disciplines, and an introduction to algebraic structures.
- To present rich new concepts in a way that sparks students' interest

Recommended prior knowledge

Basic mathematical concepts

Content of the material:

Chapter 0: Review Chapter (2 weeks)

This essential chapter will help to bring students' knowledge up to date.

1. Polynomial equations and inequalities of degree greater than or equal to 2.
2. Rational equations and inequalities.
3. Equations and inequalities with radicals.
4. Trigonometric equations and inequalities.
5. Systems of nonlinear equations.

Chapter 1: Reasoning Methods (2 Week).

1. Direct reasoning.
2. Reasoning by contraposition.
3. Proof by contradiction.
4. Reasoning by counterexample
5. Proof by induction.

Chapter 2: Binary Relations and Applications (4 weeks)

1. Binary Relations: Definitions (binary relation and its properties), Order relation, Equivalence relation
2. Functions and applications, Definitions (function, domain of definition, application, composition), direct image and inverse image of a set, Injection, surjection, bijection and inverse application

Chapter 3: Algebraic Structures (2 weeks)

1. Definitions (internal decomposition law and its properties).
2. Groups, subgroups and group morphisms.
3. Rings and bodies.

Chapter 4: The Field of Complex Numbers (2 weeks)

1. Definition of a complex number as a pair of real numbers

2. Presentations of a complex number: Algebraic presentation, Trigonometric presentation and De Moivre's formula, Geometric presentation, Exponential presentation (application: linearization of cosp.sinq)
3. Roots of a complex number: Square roots and solving the equation
$az^2 + bz + c = 0$, nth roots of a complex number

Evaluation method:
Written tests, homework assignments, final exam

Bibliographical references

1- F. Ayres Jr, Theory and Applications of Differential and Integral Calculus - 1175 solved exercises, McGraw-Hill.
2- F. Ayres Jr, Theory and Applications of Differential Equations - 560 Solved Exercises, McGraw-Hill.
3- J. Lelong-Ferrand, JM Arnaudiès, Mathematics Course - Differential Equations, Multiple Integrals, Volume 4, Dunod University.
4- M. Krasnov, Collection of Problems on Ordinary Differential Equations, Moscow Edition
5- N. Piskunov, Differential and Integral Calculus, Volume 1, Moscow Edition
6- J. Quinet, Elementary Course of Higher Mathematics 3- Integral Calculus and Series, Dunod.
7- J. Quinet, Elementary Course of Higher Mathematics 4- Differential Equations, Dunod.
8- J. Quinet, Elementary Course of Higher Mathematics 2- Usual Functions, Dunod.
9- J. Quinet, Elementary Course of Higher Mathematics 1- Algebra, Dunod.
10- J. Rivaud, Algebra: Preparatory Classes and University Volume 1, Exercises with solutions, Vuibert.

Semester 1
Teaching Unit: UEF 1.2
Subject 1: Elements of Chemistry
VHS: 90h00 (Course: 1h30, TUTORIALS: 3h00, PRACTICAL: 1h30)
Credits: 7
Coefficient: 4

Teaching objectives

The teaching of this subject allows the student to acquire basic formalisms in chemistry, particularly within the material describing the atom, chemical elements and the periodic table with energy quantization. To make students more capable of solving general chemistry problems.

Recommended prior knowledge

Basic concepts of mathematics and physics.

Content of the material:

Chapter 1: Fundamental Concepts (3 weeks)

I. Definition of Matter
II. Changes of state of matter
III. Classification of matter
IV. Concepts of atom, molecules, mole and Avogadro's number
V. Law of conservation of mass (Lavoisier), chemical reaction
VI. Qualitative and quantitative aspects of the material

Chapter 2: Structure of the atom (3 weeks)

I. Electron: Demonstration: J.J. Thomson's experiment, Properties of cathode rays
II. Core: Evidence: Rutherford's experiment, Structure of the atomic nucleus
III. Identification of elements: Representation, Atomic mass, Relative atomic mass

Chapter 3: Radioactivity (3 weeks)

I. Natural radioactivity
II. Artificial Radioactivity and Nuclear Reactions: Nuclear Fission, Nuclear Fusion, Transmutation
III. Kinetics of radioactive decay: Law of radioactive decay: Activity of a radioactive nucleus, Radioactive period or half-life

Chapter 4: Electronic Structure of the Atom (4 weeks)

I. Production of atomic emission spectra
II. Electromagnetic radiation
III. Photon theory: Emission spectrum of the hydrogen atom, Empirical Balmer-Rydberg relationship
IV. Bohr model
V. Energy of the electron in a stationary orbit

Chapter 5: Periodic Table of Elements (2 weeks)

I. Description of Mendeleev's periodic table: Characteristics of some groups, Periodicity of properties

Practical Exercises "Structure of Matter"

Practical Exercise No. 1: Preliminary practical work: Safety in the chemistry laboratory and description of equipment and glassware.

Practical Exercise No. 2: Change of state of water: Transition from liquid to solid state and from liquid to vapor state.
Practical Exercise No. 3: Determining the quantity of matter.
Practical Exercise No. 4: Determination of molecular mass.
Practical Exercise No. 5: Uncertainty calculation - Determination of the ionic radius
Practical Exercise No. 6: Determination of partial molar volumes in a binary solution.
Practical Exercise No. 7: Qualitative analysis of cations (1er2th3thand 4thband).
Practical Exercise No. 8: Qualitative analysis of anions.
Practical Exercise No. 9: Identification of metal ions by the flame method
Practical Exercise No. 10: Separation and recrystallization of benzoic acid.
Practical Exercise No. 11: Construction and study of some compact structures.
Practical Exercise No. 12: Study of ionic structures

Evaluation method:
Written tests, homework assignments, final exam

Bibliographical references
1. Ouahes, Devallez, General Chemistry, OPU.
2. SS Zumdhal & coll., General Chemistry, De Boeck University.
3. Y. Jean, Electronic structure of molecules: 1 from the atom to simple molecules, 3rd edition, Dunod, 2003.
4. F. Vassaux, Chemistry in IUT and BTS.
5. A. Casalot & A. Durupthy, Inorganic Chemistry 2nd cycle course, Hachette.
6. P. Arnaud, Course in Physical Chemistry, Ed. Dunod.
7. M. Guymont, Structure of Matter, Belin Coll., 2003.
8. G. Devore, General Chemistry: T1, study of structures, Coll. Vuibert, 1980.
9. M. Karapetiantz, Constitution of Matter, Ed. Mir, 1980.

Semester 1
Teaching Unit: UEF 1.2

Subject 2: Elements of Mechanics
VHS: 90h00 (Course: 1h30, TUTORIALS: 3h00, PRACTICAL: 1h30)
Credits: 7
Coefficient: 4

Teaching objectives
Introduce the student to the basics of point mechanics through three main parts: Kinematics, Dynamics and Work and Energy.

Recommended prior knowledge
Basic concepts of mathematics and physics.

Contents of the material:

Mathematical reminders **(2 Weeks)**
1- Dimensional equations
2-Vector calculus: dot product (norm), cross product, functions of several variables, differentiation. Vector analysis: the gradient operator, curl operator, etc.

Chapter 1. Kinematic **(5 Weeks)**
1. Position vector in coordinate systems (Cartesian, cylindrical, spherical, curvilinear) – law of motion – trajectory. 2. Velocity and acceleration in coordinate systems. 3. Applications: Motion of a point mass in different coordinate systems. 4. Relative motion.

Chapter 2. Dynamics: **(4 Weeks)**
1- Generalities: Mass - Force - Moment of force - Absolute and Galilean frame of reference. 2- Newton's laws. 3- Principle of conservation of momentum. 4- Differential equation of motion. 5- Angular momentum. 6- Applications of the fundamental law for forces (constant, time-dependent, velocity-dependent, central force, etc.).

Chapter 3.Work and energy **(4 Weeks)**
1- Work done by a force. 2- Kinetic energy. 3- Potential energy – Examples of potential energy (gravity, gravitational force, elastic force). 4- Conservative and non-conservative forces – Theorem of total energy.

Practical Exercises:
- Measurement and calculation of uncertainties - Free fall - Inclined plane - Circular motion - Simple pendulum - Oscillating pendulum - Solid-solid friction

Evaluation method:
Written tests, homework assignments, final exam

Bibliographical references:
1. A. Gibaud,Mr. Henry;Physics course - Mechanics of a point - Course and solved exercises;Dunod, 2007.
2. P. Fishbane et al. ; Physics For Scientists and Engineers with Modern Physics, 3rd Ed.; 2005.
3. PA Tipler, G. Mosca; Physics For Scientists and Engineers, 6th Ed., WH Freeman Company, 2008.

Semester 1
Teaching Unit: UEF 1.1

Subject 1: Probability and Statistics
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Objectives of the subject

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

Recommended prior knowledge

The basics of programming acquired in Math 1 and Math 2

Content of the material:

Part A: Statistics

Chapter 1: Basic Definitions (1 week)

A.1.1 Concepts of population, sample, variables, categories
A.1.2 Different types of statistical variables: qualitative, quantitative, discrete, continues.

Chapter 2: Statistical Series with One Variable (3 weeks)

A.2.1 Number, Frequency, Percentage.
A.2.2 Cumulative number, Cumulative frequency.
A.2.3 Graphical representations: bar chart, pie chart, bar graph. Frequency polygon. Histogram. Cumulative curves.
A.2.4 Position characteristics
A.2.5 Dispersion characteristics: range, variance and standard deviation, coefficient of variation.
A.2.6 Shape characteristics.

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

A.3.1 Data tables (contingency table). Scatter plot.
A.3.2 Marginal and conditional distributions. Covariance.
A.3.3 Linear correlation coefficient. Regression line and Mayer line.
A.3.4 Regression curves, regression corridor and correlation ratio.
A.3.5 Functional adjustment.

Part B: Probabilities

Chapter 1: Combinatorial Analysis (1 Week)

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

Chapter 2: Introduction to Probability (2 weeks)

B.2.1 Event Algebra
B.2.2 Definitions
B.2.3 Probability Spaces
B.2.4 General Probability Theorems

Chapter 3: Conditioning and Independence (1 week)

B.3.1 Packaging,
B.3.2 Independence,
B.3.3 Bayes' Formula.

Chapter 4: Random Variables (1 Week)

B.4.1 Definitions and properties,
B.4.2 Distribution function,
B.4.3 Mathematical expectation,
B.4.4 Covariance and moments.

Chapter 5: Common Discrete Probability Laws (1 Week)

Bernoulli, binomial, Poisson, ...

Chapter 6: Common Continuous Probability Laws (2 Weeks)

Uniform, normal, exponential,...

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references:

[1] Pierre Dagnélie. Theoretical and Applied Statistics. De Boeck University, 1998.
[2] Rick Durrett. Elementary probability for applications. Cambridge University Press, 2009.
[3] Richard Arnold Johnson and Gouri K. Bhattacharyya. Statistics: principles and methods. Wiley, 1996.
[4] Aurelio Mattei. Statistical Inference and Decision: Theory and Application to Business Management. P. Lang, 2000.
[5] Sheldon M. Ross. Introduction to Probability. Presses polytechniques et universitaires romandes, 2007.
[6] Gilbert Saporta. Probabilities, data analysis and statistics. Technip, 1990

Semester 1
Teaching Unit: UEM 1.1

Subject 2: Computer Structure and Applications
VHS: 45h00 (practical: 3h00)
Credits: 2
Coefficient: 2

Teaching objectives:
The aim of this course is to enable students to learn to program using a high-level language (PYTHON). The concept of algorithms must be implicitly addressed during the language learning process.

Recommended prior knowledge
Basic concepts of web technology

Content of the material:

Part 1. Introduction to Computer Science **(2 Weeks)**

1- Definition of computer science
3- Information coding systems
4- How a computer works

Part 2. Concepts of Algorithm and Program **(13 Weeks)**

1- Concept of an algorithm/program (1 Week)
2- Approach and analysis of a problem (2 Weeks)
3- Data Structure: Constants and Variables, Data Types (1 Week)
4- Operators: Assignment operator, Relational operators, Logical operators, Arithmetic operations, Order of operations (1 Week)
5- Entry/exit operations (2 weeks)
6- Control structures: Conditional control structures, Repetitive control structures (3 Weeks)
7- Functions/Modules: (3 Weeks)
Predefined modules, import and use
Function types (built-in, user), function declarations, function callbacks, local variables, global variables, docstrings…

Practical Exercises:
The purpose of the practical sessions is to illustrate the concepts taught during the lectures. These sessions must begin with the lectures according to the following schedule:

- Practical session for initiation and familiarization with the computer from a hardware and operating systems perspective (exploration of the different functionalities of OSs)
- Introductory practical session on using a programming environment (Editing, Assembly, Compilation, etc.)
- Practical application of programming techniques seen in class.

Evaluation method:
Written tests, homework assignments, final exam

Bibliographical references

1- John Paul Mueller and Luca Massaron, Algorithms for Dummies (large format), 2017.
2- Charles E. Leiserson, Clifford Stein and Thomas H. Cormen, Algorithmics: Course with 957 exercises and 158 problems, 2017.
3- Thomas H. Cormen, Algorithms: Basic Concepts, 2013.
4- H. Bhasin PYTHON BASICS, , Virginia Boston, Massachusetts 2019

5- Joe THOMSON: Python's Companion the Most Complete Step-by-Step Guide to Python Programming 2016

VHS: 22h30(course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The main objective of this course is to facilitate an individual's immersion in student life and their transition to responsible adulthood. It aims to develop students' awareness of ethical principles, introduce them to the rules governing life at the university (their rights and obligations towards the university community) and in the professional world, and raise awareness of the importance of respecting and valuing intellectual property. Explain to them the risks of moral evils such as corruption and how to combat them.

Recommended prior knowledge:

None

Content of the material:

I. Fundamental Concepts –مفاهم أساسية **(2 weeks)**

Definitions:

1. Moral:
2. Ethics:
3. Ethics "Theory of Duty":
4. The law:
5. Distinction between the different concepts
   A. Distinction between ethics and morality
   B. Distinction between ethics and professional conduct

II. Reference Frameworks –المرجعيات **(2 weeks)**

Philosophical references
The religious reference
The evolution of civilizations
The institutional reference

III.The University Franchise –الحرم الجامعي **(3 weeks)**

The Concept of University Franchises
Regulatory texts
University franchise royalties
Actors on the university campus

IV. University Values –القيم الجامعية **(2 weeks)**

Social Values
Community Values
Professional Values

V. Rights and Responsibilities **(2 weeks)**

Student Rights
The student's homework
Teachers' rights
Obligations of the professor-researcher
Obligations of administrative and technical staff

VI. University Relations **(2 weeks)**

Definition of the concept of university relations
Student-teacher relations
Student-student relations
Student-Staff Relations
Student-Association Member Relations

VII. Practices **(2 weeks)**

Best practices for the teacher
Best practices for the student

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references

1. Collection of ethics and professional conduct courses from Algerian universities.
2. BARBERI (J.-F.), 'Morality and Company Law',*The Small Posters,*No. 68, June 7, 1995.
3. J. Russ,*Contemporary ethical thought*Paris, PUF,*What do I know?*1995.
4. LEGAULT, GA, Professionalism and ethical deliberation, Quebec, Presses de l'Université du Québec, 2003.
5. SIROUX, D., 'Deontology', in M. Canto-Sperber (ed.), Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004.
6. Prairat, E. (2009). The teaching profession in the age of ethics. Education and Societies, 23.
7. https://elearning.univannaba.dz/pluginfile.php/39773/mod_resource/content/1/Cours%20Ethique%20et%20la%20d%C3%A9ontologie.pdf.

Semester 1
Teaching Unit: UET 1.1
Subject 2: Foreign Language 1
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
The aim is to develop the following four skills in this subject: Listening comprehension, Reading comprehension, Speaking and Writing through reading and studying texts.

Recommended prior knowledge:
Basic French.

Content of the material:
Below, we offer a selection of themes covering fundamental sciences, technology, economics, social issues, communication, sports, health, and more. Teachers can choose texts from this list to develop during lessons. Alternatively, they are free to explore other themes of their choosing. Texts can be drawn from various media: daily newspapers, sports or entertainment magazines, specialized or popular science journals, books, websites, audio and video recordings, etc.
For each text, the teacher helps the student develop their language skills: listening, comprehension, and both oral and written expression. Furthermore, the student must use this text to identify the grammatical structures they will develop during the same lesson. We provide here, as an illustration, a set of grammatical structures that can be developed as examples. Of course, the aim is not to develop them all or in the same way. Some can be recalled, and others can be explained in detail.

Examples of themes	Grammatical structures
Climate change	Punctuation. Proper nouns. Articles.
Pollution	Grammatical functions: The noun, The verb, The pronouns,
The electric car	The adjective, The adverb.
Robots	The object pronoun ''le, la, les, lui, leur, y, en, me, te, … ''
Artificial intelligence	The agreements.
The Nobel Prize	The negative sentence. Not …, Not … yet, Not … anymore,
The Olympic Games	Never … ever, Not … at all, …
Sport in schools	The interrogative sentence. Questions with ''Who, What,
The Sahara	Which'', Questions with ''When, Where, How many, Why,
The currency	How, Which, Which''.
Assembly line work	The exclamatory sentence.
Ecology	Reflexive verbs. Impersonal verbs.
Nanotechnology	The tenses of the indicative mood: Present, Future, past
Fiber optics	perfect, simple past, Imperfect.
The engineering profession	…
The power plant	
Energy efficiency	
The smart building	
Wind energy	
Solar energy	

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references:

1. Mr. Badefort, Objective: International French Test, Edulang, 2006.
2. O. Bertrand, I. Schaffner, Succeeding in the TCF, Exercises and training activities, Les éditions de l'école polytechnique, 2009.
3. M. Boulares, J.-L. Frerot, Progressive French Grammar with 400 exercises, Advanced level, CLE International.
4. Collective work, Besherelles: Grammar for all, Hatier.
5. Collective work, Besherelles: Conjugation for all, Hatier.
6. Mr. Grégoire, Progressive French Grammar with 400 exercises, Beginner level, CLE International, 1997.
7. A. Hasni et al., La formation à l'enseignement des sciences et des technologies au secondaire, Presses de l'université du Québec, 2006.
8. J.-L. Lebrun, Practical Guide to Scientific Writing, EDP Sciences, 2007.
9. JM Robert, Difficulties of French, Hachette,
10. C. Tisset, Teaching the French language at school: Grammar, Spelling and Conjugation, Hachette Education, 2005.
11. J. Bossé-Andrieu, Abridged Rules of Grammar and Spelling, Presses de l'université du Québec, 2001.
12. J.-P. Colin, Le français tout simplement, Eyrolles, 2010.
13. Collective work, French language assessment test, Hachette, 2001.
14. Y. Delatour et al., Practical French Grammar in 80 sheets with corrected exercises, Hachette, 2000.
15. Ch. Descotes et al., L'Exercisier: l'expression française pour le niveau intermédiaire, Presses Universitaires de Grenoble, 1993.
16. H. Jaraush, C. Tufts, Sur le Vif, Heinle Cengage Learning, 2011.

- Detailed program by subject for semester 2

Semester 2
Teaching Unit: UEF 2.1
Subject 1: Analysis 2
VHS: 90h00 (Course: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Teaching objectives

Students are guided, step by step, towards an understanding of the mathematics relevant to their university studies. By the end of the course, students should be able to: solve first and second degree differential equations; solve integrals of rational, exponential, trigonometric, and polynomial functions; and solve systems of linear equations using various methods.

Recommended prior knowledge

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

Content of the material:

Chapter 1: Limited Developments (4 weeks)

1. Comparison relationships
2. Taylor series expansions in the neighborhood of zero 2.1 Definitions of a Taylor series expansion and the Taylor-Lagrange theorem 2.2 Common Taylor series expansions 2.3 Operations on Taylor series expansions
3. Taylor series expansion in the neighborhood of a point, in the neighborhood of infinity, and generalized Taylor series expansion
4. Applications of Taylor series expansions (calculation of limits, equations of the tangent and the asymptote)

Chapter 2: Calculating Antiderivatives (5 weeks)

1. Definitions and properties (antiderivative, integral and definite integral)
2. Integration methods
   Part-based integration
   Integration by substitution
3. Integration of a rational fraction
4. Integrating a rational fraction with respect to sin and cos
5. Integrating a rational fraction in exponential
6. Integrating a rational function in sin(h) or a fraction cos(h)

Chapter 3: Differential Equations (3 weeks)

1. Definitions
2. First-order differential equations. 2.1 Separable differential equations. 2.2 Linear differential equations. 2.3 Bernoulli differential equations. 2.4 Homogeneous differential equations with respect to x and y:
3. Second-order linear differential equations with constant coefficients.

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references

1- F. Ayres Jr, Theory and Applications of Differential and Integral Calculus - 1175 solved exercises, McGraw-Hill.
2- F. Ayres Jr, Theory and Applications of Differential Equations - 560 Solved Exercises, McGraw-Hill.
3- J. Lelong-Ferrand, JM Arnaudiès, Mathematics Course - Differential Equations, Multiple Integrals, Volume 4, Dunod University.
4- M. Krasnov, Collection of Problems on Ordinary Differential Equations, Moscow Edition
5- N. Piskunov, Differential and Integral Calculus, Volume 1, Moscow Edition
6- J. Quinet, Elementary Course of Higher Mathematics 3- Integral Calculus and Series, Dunod.
7- J. Quinet, Elementary Course of Higher Mathematics 4- Differential Equations, Dunod.
8- J. Quinet, Elementary Course of Higher Mathematics 2- Usual Functions, Dunod.
9- J. Quinet, Elementary Course of Higher Mathematics 1- Algebra, Dunod.
10- J. Rivaud, Algebra: Preparatory Classes and University Volume 1, Exercises with solutions, Vuibert.

Semester 2
Teaching Unit: UEF 2.1
Subject 2: Algebra 2
VHS: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

The program is organized around two objectives:

- Study of fundamental concepts relating to finite dimension vector spaces such as basis, dimension, rank, and teaching the student the echeloning process which will be very useful to him later.

-Acquire the necessary knowledge concerning linear transformations, their matrix representations, change-of-basis matrices, the calculation of determinants, the characteristic polynomial and the eigenvalues of a matrix, the diagonalization and triangularization of a matrix and the reduction of quadratic forms.

Recommended prior knowledge

Basic concepts of algebra1

Content of the material:

Chapter 1: Vector spaces and linear transformations (4 weeks)

I Vector spaces, vector subspaces.
- I.1 Definitions
- I.2 Free families, generating families and bases

II. Linear Applications
- II.1 Definitions
- II.2 Rank Theorem

Chapter 2: Matrix Calculus (4 weeks)

1. Definitions (matrix, special matrices, matrix associated with a linear transformation).
2. Matrix operations.
3. Invertible matrices.
4. Determinant of a square matrix.
5. Determining the inverse of an invertible matrix
   - 5.1 Method of determinants
   - 5.2 Pivot or staggering method
6. Rank of a matrix

Chapter 3: Systems of linear equations (4 weeks)

1. Definitions (system of linear equations, associated matrix)
2. Solving a system of linear equations 2.1 case where the associated matrix is invertible 2.2 case where the associated matrix is not invertible

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references

1- A. Kurosh: Course in Higher Algebra. MIR Moscow Edition.

2- D. Fadeev and I. Sominsky: Collection of exercises in higher algebra. MIR Moscow Edition.
3- J. Rivaud: Exercises with solutions volume 1 VUIBERT.
4- J. Rivaud: Exercises with solutions volume 2 VUIBERT.
5- Jean-Pierre Escofier: All the algebra of the bachelor's degree. Course and solved exercises. Dunod.
6- J. Lelong-Ferrand, J. Marnaudiès: Mathematics Course. Volume 1 Algebra 3rd edition. Preparatory classes, first cycle of university studies. Dunod.
7- A. Doneddu: Algebra and Geometry 7 Special Mathematics First year university. VUIBERT.
8- COLLET Valérie: MATHS All of the second year. Ellipses

Semester 2
Teaching Unit: UEF 2.2
Subject 1: Electricity and Magnetism
VHS: 90h00 (Course: 1h30, tutorials: 3h00, practical: 1h30)
Credits: 7
Coefficient: 4

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

Recommended prior knowledge
Mathematics, Physics.

Content of the material:
Mathematical reminders: (1 Week)
1- Elements of length, area, and volume in Cartesian, cylindrical, and spherical coordinate systems. Solid angle, The operators (the gradient, the curl, Nabla, the Laplacian and the divergence).
2- Multiple derivatives and integrals.

Chapter I. Electrostatics: (6 Weeks)
1- Electrostatic charges and fields. Electrostatic interaction force - Coulomb's Law.
2- Electrostatic potential. 3- Electric dipole. 4- Electric field flux. 5- Gauss's theorem. 6- Conductors in equilibrium. 7- Electrostatic pressure. 8- Capacitance of a conductor and a capacitor.

Chapter II. Electrodynamics: (4 Weeks)
1. Electrical conductor. 2. Ohm's Law. 3. Joule's Law. 4. Electrical circuits. 5. Application of Ohm's Law to networks. 6. Kirchhoff's Laws. Thévenin's Theorem.

Chapter III. Electromagnetism: (4 Weeks)
1- Magnetic field: Definition of a magnetic field, Biot-Savart Law, Ampère's Theorem, Calculation of magnetic fields created by permanent currents.
2- Induction Phenomena: Induction phenomena (circuit in a changing magnetic field and moving circuit in a magnetic field)permanent), F Lorentz force, F Laplace force, Faraday's law, Lenz's law, Application to coupled circuits.

Practical Exercise Content:

5 manipulations minimum (3 hours / 15 days)

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

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references:

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

Semester 2
Teaching Unit: UEF 2.2
Subject 2: Thermodynamics
VHS: 90h00 (Course: 1h30, tutorials: 3h00, practical: 1h30)
Credits: 7
Coefficient: 4

Teaching objectives

To provide the necessary foundations of classical thermodynamics for applications in combustion and heat engines. To standardize students' knowledge. The skills to be acquired are: The acquisition of a scientific basis in classical thermodynamics; The application of thermodynamics to various systems; The statement, explanation, and understanding of the fundamental principles of thermodynamics.

Recommended prior knowledge

Basic mathematics.

Contents of the material:

Chapter 1: Generalities on Thermodynamics (3 Weeks)

1- Fundamental properties of state functions. 2- Definitions of thermodynamic systems and the external environment. 3- Description of a thermodynamic system. 4- Evolution and thermodynamic equilibrium states of a system. 5- Possible transfers between the system and the external environment. 6- Transformations of the state of a system (operation, evolution). 7- Review of the ideal gas laws.

Chapter 2The first law of thermodynamics: (3 weeks)

1. Work, heat, internal energy, concept of conservation of energy. 2. The first law of thermodynamics: statement, concept of internal energy of a system, application to an ideal gas, the enthalpy function, heat capacity, reversible transformations (isochoric, isobaric, isothermal, adiabatic).

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

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

Chapter 4The second law of thermodynamics (3 weeks)

1. The second law of thermodynamics for a closed system. 2. Statement of the second law: Entropy of a closed, isolated system. 3. Calculation of the entropy change: reversible isothermal transformation, reversible isochoric transformation, reversible isobaric transformation, adiabatic transformation, during a change of state, during a chemical reaction.

Chapter 5: The 3rd Principle and Absolute Entropy **(1 week)**

Chapter 6Free energy and enthalpy – Criteria for the evolution of a system (2 weeks)

1. Introduction. 2. Energy and Gibbs Free Energy. 3. Chemical Equilibria

Practical work content:

1- Ideal gas law: verification of Boyle's law
Materials (*): Graduated glass tubes (Ø = approx. 1.5 cm) with tap, flexible tube, large ruler, mercury and supports.

2- Measurement of the coefficient γ = Cp/Cv: determination by the Clément-Désormés method Materials: bottle with tap, glass tubes (Ø= 3-5mm), flexible tubes, air pumps, U-shaped glass tubes, stopwatch, mercury, large graduated ruler, taps and supports.

3- Thermal expansion of solids
Materials: Tubes (steel, brass, copper, glass,…) L=65cm and Ø= 7mm, dial pyrometer, comparator, digital thermometers, flexible hose and circulation thermostat from 30 to 100°C.

4- Calorimetry: Measuring the quantities of heat or heat transfers between different bodies using several types of calorimetry (ice, resistance, etc.). Materials: Dewar flask with lid, copper shot, lead shot, glass shot… (approx. 100 g of each), thermometers, balance, 220V/550W steam generator, beaker, calorimeter, heating unit with lid and accessories, aluminum beaker, Bunsen burner, ice and supports.

5- Determination of the latent heat of vaporization
Equipment: Devices for determining steam pressure (boiler), a 60 atm pressure gauge, a 0-250°C thermometer and a gas burner (Bunsen burner)

6- Calibration of a thermocouple (measurement of its thermoelectric power)
Materials: Wires (copper and constantin), two beakers, thermometers (0-100°C), digital microvoltmeter, a gas burner, ice and a candle.

7- Heat propagation in a cylindrical metal bar. Materials: Metal tubes l = 1.5 m and Ø = 2 cm, digital thermometers, stopwatch, tube furnace and supports.

8- Heat transport: thermal convection. Materials: Thermosiphon, Bunsen burner, powdered dye and supports.

9- Thermal insulation
Materials: Heat chamber with accessories.

10- Kinetic theory of gases: variation of the volume of gases as a function of pressure at constant temperature (Boyle-Mariotte law).

Evaluation method:
Written tests, homework assignments, final exam

Bibliographical references:

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

Semester 2
Teaching Unit: UEM 2.1
Subject 1: Technical Drawing
VHS: 45h00 (practical: 3h00)
Credits: 2
Coefficient: 2

Course description and objectives:
Introduction to technical drawing, standards and conventions, and blueprint reading. Introduction to 3D drawing and mechanical part modeling. Introduction to engineering design techniques and problem-solving through drawing.

Prerequisites: Basic geometric shapes

The content of the material:

Chapter 1: Technical Drawing
- 1.1 General Introduction
- 1.2 Writings
- 1.3 Presentations of the drawings
- 1.4 Features
- 1.5 Scales

Chapter 2: Geometric Constructions
- **2.1**Intersections
- 2.2 Connections

Chapter 3: Descriptive Geometry
- 3.1 Projection of the point
- 3.2 Projection of a line onto a plane
  - 3.2.1 Line parallel to the plane
  - 3.2.2 Line perpendicular to the plane
- 3.3 Projection of a surface onto a plane
  - 3.3.1 Surface parallel to the plane
  - 3.3.2 Surface inclined with respect to the plane
  - 3.3.3 Surface perpendicular to the plane

Chapter 4: Orthogonal Projections
- 4.1 Projection of prismatic pieces
- 4.2 Projection of cylindrical parts
- 4.3 Projection of conical parts
- 4.4 Projections of mixed plays

Chapter 5: Perspective Drawing
- 5.1 Cavalier Perspectives
- 5.2 Isometric perspectives

Chapter 6: Quotations
- 6.1 General rating rules
- 6.2 Applications

Chapter 7: Sections and Cuts
- 7.1 Simple Cuts

7.2 Exit Sections
7.3 Folded sections

Chapter 8: Assembly Drawings

8.1 Definition
8.2 Applications
8.3 Component Part Definition Drawings

Evaluation method:

Written tests, homework assignments, final exam

Bibliographical references:

1- Giesecke, Mitchell, Spencer, Hill, Dygdon and Novak, Technical Drawing, 12th edition, 2003, ISBN 0-13-008183-3
2- A. Chevalier; Guide for industrial draftsmen. Hachette technique; Paris, 2011.
3- A. Cordeau, C. Corbet; Construction Technology File; Casteilla; Paris, 2001
4- A. Ricordeau; Descriptive Geometry Applied to Drawing; Casteilla; Paris, 2009

Semester 2
Teaching Unit: UEM 2.1
Subject 1: Programming (Computer Science 2)
VHS: 45h00 (practical: 3h00)
Credits: 2
Coefficient: 2

Teaching objectives:

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

Recommended prior knowledge

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

Content of the material:

Chapter 1: Indexed Variables (7 Weeks)

1-List: operations on lists, slicing…etc.
2- Lists for implementing vectors and matrices,
3-Introduction to nympy's ndarray (Ndarray vs List)
a- One-dimensional arrays: vector (1 array): Memory representation, Operations on vectors
b- Two-dimensional arrays; Matrix (2darray): Memory representation, Matrix operations

Chapter 2: Matrices and Linear Algebra (4 Weeks)

Introduction to Num Py. Linear calculations: Matrix calculus: Determinant, trace; inverse, vector and eigenvalues, system of linear equations…etc.

Chapter 3: Files (4 Weeks)

1- File access methods
2- Reading and writing to a text/binary file
3- The concept of context manager in files
4- Reading and writing CSV files

Computer Science Lab 2:

- Plan a number of practical exercises to put into practice the programming techniques seen during the course.
- Practical application of programming techniques seen in class.

Evaluation method:

Written tests, homework assignments, final exam

Bibliographical references:

1- Algorithms for Dummies (Large Format) by John Paul Mueller (Informatician, USA) and Luca Massaron, 2017
2- Algorithms: Course with 957 exercises and 158 problems. Book by Charles E. Leiserson, Clifford Stein and Thomas H. Cormen, 2017
1- Algorithms: Basic Concepts Book by Thomas H. Cormen 2013.

2- Joe THOMSON: Python's Companion The Most Complete Step-by-Step Guide to Python Programming 2016
3- Tim Hall and JP Stacey: Python 3 for Absolute Beginners 2009

Semester 2
Teaching Unit: UET 2.1
Subject 1: Engineering Professions
VHS: 22h30(course: 1h30)
Credits: 1
Coefficient: 1

Goals :
The course aims, firstly, to introduce students to all the fields of study covered by the Science and Technology domain, and secondly, to present a range of careers that these fields lead to. In the same vein, this subject introduces the emerging challenges of sustainable development and the new professions that may arise from it.

Content of the material:
1. What are engineering sciences?
The engineering profession: history and challenges of the 21st century; searching for a job/recruitment ad by keyword; creating a simple job description (job title, company, main activities, required skills (knowledge, know-how, interpersonal skills)).
2. Fields of study in Electronics, Telecommunications, Biomedical Engineering, Electrical Engineering, Electromechanics, Optics & Precision Mechanics:
- Definitions, application areas (Home automation, embedded automotive applications, Video surveillance, Mobile telephony, Fiber optics, Advanced scientific instrumentation, Medical imaging and instrumentation, Giant mirrors, Contact lenses, Electrical power transmission and distribution, Power generation plants, Energy efficiency, Industrial equipment maintenance, Elevators, Wind turbines, …
- The role of the specialist in these areas.
3. Automation and Industrial Engineering programs:
- Definitions, areas of application (Automated industrial chains, Numerically Controlled machine tools, Robotics, Inventory management, Goods traffic management, Quality, - Role of the specialist in these areas.
4. Process Engineering, Hydrocarbons and Petrochemical Industries:
- Definitions, Pharmaceutical industry, Food processing industry, Leather and textile industry, Biotechnology, Chemical and petrochemical industry, Plastics industry, Energy sector (oil, gas), …
- The role of the specialist in these areas.
1. Industrial Health and Safety (HSI) and Mining Engineering programs:
- Definitions and areas of application (Security of property and people, Environmental problems, Exploration and exploitation of mineral resources, …)
- The role of the specialist in these areas.
2. Climate Engineering and Transport Engineering Programs- Definitions, areas of application (Air conditioning, Smart buildings, Transport security, Traffic management and road, air, and naval transport, …)
- The role of the specialist in these areas.
3. Civil Engineering, Hydraulics and Public Works programs: (2 weeks)
- Definitions and areas of application (Construction materials, Major road and rail infrastructure, Bridges, Airports, Dams, Drinking water supply and sanitation, Hydraulic flows, Water resource management, Public works and land development, Smart cities, …)
- The role of the specialist in these areas.
4. Aeronautics, Mechanical Engineering, Maritime Engineering and Metallurgy sectors:
- Definitions and areas of application (Aeronautics, Avionics, Automotive industry, Ports, Dikes, Industrial equipment production, Steel industry, Metal processing, …)
- The role of the specialist in these areas.

group work: Development of job descriptions for jobs in each sector based on recruitment announcements found on job search websites (e.g., http://www.onisep.fr/Decouvrir-les-metiers, www.indeed.fr, www.pole-emploi.fr) (1 sector / group).
Depending on the capacities of the institutions, recommend using doctoral students and former graduates of the institution in a tutoring/mentoring scheme where each group can call on its tutor/mentor to develop the job description/discover the different ST professions.

Student's individual work for this subject:
The instructor in charge of this subject can inform students that they can still be assessed by having them prepare career profiles. Students can also be asked to watch a popular science film related to their chosen career at home (after being provided with either the film electronically or an internet link) and then submit a written report or give an oral presentation summarizing the film, etc. The weighting of these activities is left to the discretion of the instructor and the training team, who are solely responsible for determining the best way to incorporate this individual work into the overall final exam grade.

Evaluation method:
Continuous assessment, Final exam,

Bibliographical references:
1- What jobs for tomorrow? Publisher: ONISEP, 2016, Collection: Les Dossiers.
2- J. Douënel and I. Sédès, Choosing a job according to your profile, Editions d'Organisation, Collection: Employment & career, 2010.
3- V. Bertereau and E. Ratière, What profession are you made for? Publisher: L'Étudiant, 6th edition, Collection: Professions, 2015.
4- The big book of professions, Publisher: L'Étudiant, Collection: Professions, 2017.
5- Careers in the aeronautical and space industry, Collection: Parcours, Edition: ONISEP, 2017.
6- Careers in electronics and robotics, Collection: Parcours, Edition: ONISEP, 2015.
7- The building and public works trades, Collection: Parcours, Edition: ONISEP, 2016.
9- The professions of transport and logistics, Collection: Parcours, Edition: ONISEP, 2016.
9- Energy professions, Collection: Parcours, Edition: ONISEP, 2016.
10- The mechanical trades, Collection: Parcours, Edition: ONISEP, 2014.
11- Careers in Chemistry, Collection: Parcours, Edition: ONISEP, 2017.
12- Web professions, Collection: Career Paths, Edition: ONISEP, 2015.

Semester 2
Teaching Unit: UET 2.1
Subject 2: Foreign Language 1 (French or English)
VHS: 22h30(course: 1h30)
Credits: 1
Coefficient: 1

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

Recommended prior knowledge:
Basic English.

Contents:
The English syllabus consists of a set of texts containing scientific and technical parts. The chosen texts must be used to study scientific and technical English and Grammar acquisition.
The texts must be selected according to the vocabulary built up, familiarization with both scientific and matters in English for further understanding. Therefore, each text will be defined by a set of vocabulary concepts, a set of special sentences (idioms) and comprehension questions.
The texts must also contain a terminology which means the translation of some words from English to French one. , the activity at the end of each session must include a translation of long statements which are selected from the texts.

Examples for some lectures:	**Examples of Word Study: Patterns**
Radioactivity.	Explanation of Cause
Chain Reaction.	Result
Reactor Cooling System.	Conditions (if), Conditions (Restrictive)
Conductor and Conductivity.	Eventuality
Induction Motors.	Manner
Electrolysis.	When, Once, If, etc. + Past Participle
Liquid Flow and Metering.	It is + Adjective + to
Liquid Pumps.	As
Petroleum.	It is + Adjective or Verb + that…
Road Foundations.	Similarity, Difference
Rigid Pavements.	In Spite of, Although
Piles for Foundations.	Formation of Adjectives
Suspension Bridges.	Phrasal Verbs

Evaluation mode:
Work-from-home, final exam

References:

1. J. Upjohn, S. Blattes, V. Jans, Minimum Competence in Scientific English, Office des Publications Universitaires, 1994.
2. AJ Herbert, The Structure of Technical English, Longman, 1972.
3. S. Berland-Delepine, Methodical Grammar of Modern English with Exercises, Ophrys, 1982.
4. Test of English as a Foreign Language – Preparation Guide, Cliffs, 1991.
5. R. Fowler, The Little, Brown Handbook, Little, Brown Company, 1980.
6. Cambridge – First Certificate in English, Cambridge books, 2008.
7. K. Wilson, Th. Healy, First Choice, Oxford, 2007.
8. M. Mann, S. Tayore-Knowles, Destination: Grammar & Vocabulary with Answer Key, MacMillan, 2006.

9. E. Hamby, Ph. Bedford Robinson, Special English Computer Applications, Cassell, 1980.
10. P. Charles Brown, Norma D. Mullen, English for Computer Science, Oxford University Press, 1989.
11. Graeme Kennedy, Structure and Meaning in English: A Guide for Teachers, Pearson, 2004.
12. Anne M. Hanson, Brain-Friendly Strategies for Developing Student Writing Skills, 2nd Edition, Corwin Press, 2008.
13. Ann Bridges, How to Pass Higher English, Hodder Gibson-Hachette, 2009.
14. Claude Renucci, English: 1000 Words and expressions from the press: Vocabulary and expressions from the economic, social and political world, Fernand Nathan, 2006.

- Detailed program by subject for semester 3

Semester 3
Teaching Unit: UEF 3.1
Subject 1: Applied Mathematics
VHS: 45h00 (Course: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Teaching objectives:

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

Recommended prior knowledge

Analysis 1 & 2 and Algebra 1 & 2

Content of the material:

Chapter 1: Simple and Multiple Integrals **3 weeks**

1.1 Review of the Riemann integral and the calculation of antiderivatives. 1.2 Double and triple integrals.
1.3 Application to the calculation of areas, volumes, ...

Chapter 2: Improper Integrals **2 weeks**

2.1 Integrals of functions defined on an unbounded interval.
2.2 Integrals of functions defined on a bounded interval, infinite at one end.

Chapter 3: Differential Equations **2 weeks**

3.1 Review of ordinary differential equations.
3.2 Partial Differential Equations.
3.3 Special functions.

Chapter 4: Series **3 weeks**

4.1 Numerical series.
4.2 Sequences and series of functions.
4.3 Whole series, Fourier series.

Chapter 5: Fourier Transform **3 weeks**

5.1 Definition and properties. 5.2 Application to the resolution of differential equations.

Chapter 6: Laplace Transform **2 weeks**

6.1 Definition and properties. 6.2 Application to the resolution of differential equations.

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references:

1- F. Ayres Jr, Theory and Applications of Differential and Integral Calculus - 1175 solved exercises, McGraw-Hill.
2- F. Ayres Jr, Theory and Applications of Differential Equations - 560 Solved Exercises, McGraw-Hill.
3- J. Lelong-Ferrand, JM Arnaudiès, Mathematics Course - Differential Equations, Multiple Integrals, Volume 4, Dunod University.

4- M. Krasnov, Collection of Problems on Ordinary Differential Equations, Moscow Edition
5- N. Piskunov, Differential and Integral Calculus, Volume 1, Moscow Edition
6- J. Quinet, Elementary Course of Higher Mathematics 3- Integral Calculus and Series, Dunod.
7- J. Quinet, Elementary Course of Higher Mathematics 4- Differential Equations, Dunod.
8- MR Spiegel, Laplace Transforms, Course and Problems, 450 Solved Exercises, McGraw-Hill.

Semester 3
Teaching Unit: UEF 3.2
Subject 2: Waves and Vibrations
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practicals: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives

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

Recommended prior knowledge

First-year Mathematics and Physics Concepts

Content of the material:

Part A: Vibrations

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

Lagrange equations for a particle, Lagrange equations, Case of conservative systems, Case of friction forces depending on velocity, Case of an external force depending on time, System with several degrees of freedom.

Chapter 2: Free Oscillations of Systems with a Degree offreedom **2 weeks**

Undamped oscillations, Free oscillations of damped systems

Chapter 3: Forced Oscillations of Systems with One Degree of Freedom **1 week**

Differential equation, Mass-spring-damper system, Solution of the differential equation, Harmonic excitation, Periodic excitation, Mechanical impedance

Chapter 4: Free Oscillations of Two-Degree-of-Freedom Systems **1 week**

Introduction, Two-degree-of-freedom systems

Chapter 5: Forced Oscillations of Two-Degree-of-Freedom Systems **2 weeks**

Lagrange equations, Mass-spring-damper system, Impedance, Applications, Generalization to systems with n degrees of freedom

Part B: Waves

Chapter 1: One-Dimensional Propagation Phenomena **2 weeks**

Generalities and basic definitions, Propagation equation, Solution of the propagation equation, Sinusoidal progressive wave, Superposition of two sinusoidal progressive waves

Chapter 2: Vibrating Strings **2 weeks**

Wave equation, Harmonic progressive waves, Free oscillations of a finite-length string, Reflection and transmission

Chapter 3: Acoustic Waves in Fluids **1 week**

Wave equation, Speed of sound, Sinusoidal traveling wave, Reflection-Transmission

Chapter 4: Electromagnetic Waves **2 weeks**

Wave equation, Reflection-Transmission, Different types of electromagnetic waves

Lab content:

TP1.Mass-spring

TP2. Simple pendulum
TP3. Torsion pendulum
TP4. Oscillating electrical circuit in free and forced regime
TP5. Coupled pendulums
TP6. Transverse Oscillations in Vibrating Strings
TP7. Hoffmann grooved pulley
TP8. Electromechanical Systems (The Electrodynamic Loudspeaker)
TP9. Pohl's Pendulum
TP10. Propagation of longitudinal waves in a fluid.

Evaluation method:
Written tests, homework assignments, final exam.

Bibliographical references:

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

Semester 3
Teaching Unit: UEF 3.2
Subject 1: Mechanical Manufacturing
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practicals: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:

To provide the student with knowledge about manufacturing techniques for products, particularly mechanical products.

Recommended prior knowledge:

Basic technology, materials science,

Content of the material:

I- Metal cutting theory

1.1 Cutting materials **(1 week)**
1.2 Cutting tool geometry **(1 week)**
1.3 Chip formation mechanism **(1 week)**
1.4 Cutting forces **(1 week)**
1.5 Heating (Cutting Temperature)
1.6 Damage to cutting tools **(1 week)**
1.7 Methodology for choosing cutting parameters **(1 week)**

II- Machine Tool Technologies

2.1 Cutting movements **(1 week)**
2.2 Characterization of a machine tool (Main components) **(2 weeks)**
- Pin
- Built
- Slides

2.3 Kinematic chains **(6 weeks)**

- Motion transmission mechanisms
- Lathes, planers and vise-shapers, drills, milling machines, broaching machines, cylindrical and surface grinders, etc...

Lab Content:

Practical exercise #1: Turning a cylindrical part with 2 diameters, including facing and turning operations

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

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

- Definition of the shape, dimensions, tolerances and surface finish of the part (definition drawing)
- Sketch drawing.
- Determination of cutting regimes and development of the machining range of the part (without the grinding phase).
- Cutting out the rough draft.
- Preparation of tools, machine(s) and measuring instruments.
- Positioning, clamping of the blank, setting up and adjusting the machine.
- Performing the operations and the part

Practical Exercise #3: Correction plane and examination of surface conditions
(Using part from lab exercise #2)

- Analysis of the rough and definition drawings for practical exercise #2
- Determination of grinding regimes and development of the complete machining range of the part (including the grinding phase).
- Preparation of tools, machine and instruments for measuring surface condition (roughness).
- Positioning, clamping of the blank, setting up and adjusting the machine.
- Carrying out the rectification phase and checking the surface condition.

Practical exercise #4: Welding

- Preparing the parts to be assembled
- Choice of filler metal
- Application of the weld bead
- Cleaning and inspection

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references:

1- Engineering Techniques 2000 B.BM.BT. January 2000 Printed in France by ImprimerieStrasbourgeoise Schiltigheim- ISTRAIN 2- Roger Bonetto, Flexible Production Workshops, 2nd edition, Hermes 1987-Paris 3- G. Levallant; M. Dessoly; P. Géodossi; P. Leroux; J.C. Moulet; G. Poulachon; P. Robert, Machining by Chip Removal - From Technology to Industrial Applications, Ensam. Eyrolles Edition No. 7211- June 2005, Paris 4- Manufacturing Elements, Ellipses Edition. Copyright 1995, Paris 5- Michel Ahby, Material Selection in Mechanical Design; Dunod, 19996- Claude Hazard, Numerical Control of Machines, Foucher edition, Paris 19847- Gonzalez, Computer-Aided CNC, Foucher edition, Paris 1985.8- Philippe DEPEYRE, Course "Mechanical Manufacturing", Faculty of Science and Technology, University of Reunion, Academic Year 2004-2005

Semester 3
Teaching Unit: UEF 3.2
Subject 2: Fluid Mechanics 1
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practicals: 1h30)
Credits: 5
Coefficient: 3

Teaching objective:

The first part introduces the student to the field of fluid mechanics; fluid statics will be detailed. The second part will then consider the study of the motion of in viscid fluids, and finally, the motion of real fluids will be studied.

Prior knowledge recommended:

Content of the material:

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

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

Chapter 2: Fluid Statics **4 weeks**

1. Definition of pressure: pressure at a point in a fluid
2. Fundamental Law of Fluid Statics
3. Level surface
4. Pascal's Theorem
5. Calculation of pressure forces: Flat plate (horizontal, vertical, oblique), center of pressure, static pressure measuring instruments, atmospheric pressure measurement, barometer, Torricelli's law
2. Pressure for superimposed immiscible fluids

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

1. Continuous flow
2. Continuity equation
3. Mass flow rate and volume flow rate
4. Bernoulli's theorem, case without work exchange and with work exchange
5. Applications to flow and velocity measurements: Venturi, diaphragms, Pitot tubes…
6. Euler's Theorem

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

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

Practical Exercises:

- Viscometer
- Determination of linear and singular pressure losses
- Flow rate measurement
- Water hammer and mass oscillations
- Verification of Bernoulli's theorem
- Impact of the jet
- Flow through an opening
- Visualizing flow around an obstacle
- Determining the Reynolds number: Laminar and turbulent flow

Evaluation method:

Written tests, homework assignments, final exam

Bibliographical references:

1- Fundamentals of fluidMechanics, 6th Edition, 2009BR Munson, DF Young TH Okiishi, WW Huebsch6th Edition John Wiley & Sons
2- Fluid mechanics,YA Cengel- 2010 - Tata McGraw-Hill Education
3- Fluid Mechanics Frank M. White Fourth Edition 2003 McGraw-Hill
4- Fluid Mechanics and Hydraulics, 2nd Edition, Ronald v. Giles, Jack B. Evett, Cheng Liu, McGraw-Hill
5- S. Amiroudine,JL Battaglia**,** 'Fluid Mechanics: Course and Solved Exercises, Dunod Publishing
6- R. Comolet, 'Experimental Fluid Mechanics', Volumes 1, 2 and 3, Ed. Masson et Cie.
7- R. Ouziaux, 'Applied Fluid Mechanics', Ed. Dunod, 1978
8- BR Munson, DF Young, TH Okiishi, 'Fundamentals of fluid mechanics', Wiley & Sons. RV Gilles, 'Mécanique des fluides et hydrauliques : Cours et problèmes', Schaum Series, McGraw Hill, 1975.

Semester 3
Teaching Unit: UEF 3.2
Subject 3: Rational Mechanics
VHS: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The student will be able to understand the nature of a problem (static, kinematic, or dynamic) in solid mechanics, and will possess the tools to solve the problem within the framework of classical mechanics. This course is a prerequisite for the courses: Strength of Materials and Analytical Mechanics.

Recommended prior knowledge

The student must first assimilate Physics 1, which deals with point mechanics. Also, Mathematics 2 contains essential tools.

Content of the material:

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 Type of force: point, line, surface, volume
2.5 Classification of forces: internal forces, external forces.
2.6 Mechanical models: the point mass, the solid body

Chapter 3: Statics. **3 weeks**

3.1 Axioms of statics
3.2 Connections, supports and reactions
3.3 Axiom of Bonds
3.4 Conditions for equilibrium: Concurrent forces, Parallel forces, Plane forces

Chapter 4: Kinematics of a rigid body. **3 weeks**

4.1 Brief review of kinematic quantities for a material point.
4.2 Kinematics of a rigid body: Translational motion, Rotational motion around a fixed axis, Planar motion, Composite motion.

Chapter 5: Mass Geometry. **3 weeks**

5.1 Mass of a material system: Continuous system, Discrete system
5.2 Integral formulation of the center of mass, Definitions (linear, surface and volume cases), Discrete formulation of the center of mass, Guldin's theorems
5.3. Moment and product of inertia of rigid bodies
5.4. Inertia tensor of a rigid body: Special cases, Principal axes of inertia

5.5. Huygens' Theorem
5.6. Moment of inertia of solids with respect to any axis.

Chapter 6: Dynamics of rigid bodies. 3 weeks

6.1 Brief reminders about dynamic quantities for a material point.
6.2 Elements of rigid body kinetics: Momentum, Angular momentum, Kinetic energy
6.3 Equation of dynamics for a rigid body
6.4 Angular Momentum Theorem
6.5 Kinetic Energy Theorem
6.6 Applications: Case of pure translation, Case of rotation around a fixed axis, Combined case of translation and rotation.

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references:

1. Elements of Rational Mechanics. S. Targ. Mir Publishers, Moscow
2. Mechanics for Engineers. Statics. Russell Edition. Ferdinand P. Beer
3. General Mechanics. Course and solved exercises. Sylvie Pommier. Yves Berthaud. DUNOD.
4. General Mechanics - Theory and Application, Series Editions. MURAY R. SPIEGEL Schaum, 367p.
5. General Mechanics – Exercises and solved problems with course summaries, University Publications Office, Tahar HANI 1983, 386p.

Semester 3
Teaching Unit: UEM 3.1
Subject 1: Computer Science 3
VHS: 45h00 (course: 1h30, Practical: 1h30)
Credits: 2
Coefficient: 2

Objectives of the subject:
The course teaches students programming using easily accessible software (primarily Matlab, Scilab, Maple, etc.). This subject will be a tool for completing the numerical methods practical sessions in semester 4.

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

Content of the material:

Lab 1: Introduction to a scientific programming environment (1 Week)
(Matlab, Scilab, etc.)
Lab 2: Script Files and Data and Variable Types (2 Weeks)
Lab 3: Reading, displaying, and saving data (2 Weeks)
Lab 4: Vectors and Matrices (2 Weeks)
Lab 5: Control Instructions (For and While Loops, If and Switch Statements) (2 Weeks)
Lab 6: Function Files (2 Weeks)
Practical Exercise 7: Graphics (Managing graphic windows, plotting) (2 Weeks)
Lab 8: Using Toolbox (2 Weeks)

Evaluation method:
Written tests, homework assignments, final exam.

Bibliographical references:

1. Jean-Pierre Grenier,Getting started in algorithms with MATLAB and SCILAB,Ellipses,2007.
2. Laurent Berger, Scilab from theory to practice, 2014.
3. Bégyn Arnaud, Gras Hervé, Grenier Jean-Pierre, Programming and simulation in Scilab, 2014.
4. Thierry Audibert,Amar Oussalah,Maurice Nivat, Computer Science: Programming and scientific computing in Python and Scilab, preparatory classes for scientific studies, 1st and 2nd years, Ellipses, 2010.

Semester 3
Teaching Unit: UED 3.1
Subject 1: Electronics
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

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

Recommended prior knowledge:
Mathematics, numerical methods

Content of the material:

Chapter 1: Control Systems Terminology (1weeks)

Functional diagram of a closed-loop system. Components of a functional diagram of a closed-loop system

Chapter 2: Laplace Transform (2 weeks)

Definitions and properties

Chapter 3: Transfer Functions (2 weeks)

Algebra of functional schemes and transfer function of systems

Chapter 4: Study of a first-order closed-loop system (3 weeks)

Definition and function of the transfer function. System response to different input signals

Chapter 5: Study of a second-order closed-loop system (3 weeks)

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

Chapter 6: Bode and Nyquist diagrams of control systems (2 weeks)
Chapter 7: Stability Study of Controlled Systems (2 weeks)

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

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references:

1- Henri Bourles. Linear systems from modeling to control. Editions Lavoisier 2006, Paris.
2- Jean Marie Flans.*Industrial regulation*; Hermès 1994 ; Paris.
3- Philippe de Larminat.*Automatic control of linear systems.* Editions Hermès 1996; Paris
4- Patrick Prouvost. Automation – Control and Regulation, Dunod Edition 2010.

5- Yves GRANJON. Automatic. Dunod Edition 2010
6- Olivier Le Gallo. Automatic Control of Mechanical Systems. Dunod Publishing, 2009
7- Gérard Boujat, Patrick Anaya. Industrial Automation, 2007. Dunod Edition
8- JANET Maurice. A Concise Guide to Matrix Calculus and Operational Calculus, Euclid Edition 1982
9- Patrick Prouvost. Automation – Control and Regulation. Dunod Edition 2010.

Semester 3

Teaching Unit: UED 3.1
Subject 2: Electrotechnics
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

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

Recommended prior knowledge: The fundamental physical science lessons acquired in the first year of this course.

Content of the material:

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

Chapter 2 – Magnetic Circuits **(3 weeks)**
- 2.1 Magnetism and electricity
- 2.2 Fundamental Laws
- 2.3 Magnetic materials and 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 Connection of three-phase motors

Chapter 5 – Electrical Measurements **(3 weeks)**
- 5.1 Measurement in physics
- 5.2 Measurement quality – errors
- 5.3 Structure of digital display devices
- 5.4 Measurement of current and voltage
- 5.5 Measurements of power and energy
- 5.6 Wiring diagrams of an electrical installation - Calculation of wire cross-section.

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references:

- Exercises and problems in electrical engineering: basic concepts, networks and electrical machines; Luc Lasne; Dunod edition 2011.

- Electrical engineering: modeling and simulation of electrical machines; Rachid Abdessemed; Ellipse edition 2011.
- Electrical circuits: continuous, sinusoidal and pulsed regime, Jean-Paul Bancarel, Ellipse edition 2001.
- Analysis of electrical circuits, Charles K. Alexander and Matthew Sadiku; De Boeck edition. 2012.

Semester 3
Teaching Unit: UET 3.1

Subject 1: Technical English
VHS: 22h30(tutorials: 1h30)
Credits: 1
Coefficient: 1

Course description and objectives:

The aim is to refresh and consolidate the basic level students in English in order to familiarize with the scientific and technical subjects taught in that language (in oral or written form) and also to improve their in-depth understanding. This will allow them to confront and apply their learning to everyday situations by providing them with a comprehensive education. This training therefore offers them the opportunity to reach an intermediate level which corresponds to levels B1 and B2. The latter follows the elementary level and precedes the operational level defined by the Common European Framework of Reference for Languages (CEFR).

Prerequisites: Basic knowledge required

The content of the material:

Chapter 1.Phonetics:

1. Pronunciation of the final (ed)
2. Silent letters: definition, spelling + pronunciation of each letter

Chapter 2General Grammar:

1- Tenses

Simple present
Simple past
Simple future
Present continuous
Present perfect
Not perfect

2- Modals

eg: can, may, should, must…

3- Reported speech

4- Using English:

To compare
To define
To report

Chapter 3Texts and Activities:

Activities, scientific or technical texts are included progressively, in which we focus on the application of the previous lessons.

3.1- Writing a Report in English

Cover pages, Summary, Introduction, Method, Results, Discussion, Conclusion, Bibliography, Appendices, Summary and Keywords

3.2- Oral presentation in English

Communication, Preparation of an oral presentation

Workshops of the matter"English Language":

English lessons can be recorded on video for distribution on various platforms (Moodle, YouTube channels, streaming media…..) or by sharing on different computer media for students without internet access. The teacher in charge of this subject must organize a workshop in person every week. consisting of two groups of students with mandatory attendance.

The workshops allow students to improve their English communication skills, practice the skills they have acquired, and strengthen their vocabulary. Furthermore, these workshops help students improve their comprehension.in a communicative manner They will begin according to this schedule:

- **Reading Workshop**: to develop students' pronunciation (correct articulation, correct placement of stress, etc.),vocabulary strengthening and text comprehension
- **Oral Expression Workshop**: work on phonetics and pronunciation, learning to communicate in a professional environment, polite formulas, knowing how to listen and identify key phrases, knowing how to rephrase. To encourage student interaction, to promote students' ability to express their ideas and attitudes in a communicative manner
- **Workshop Written expression**: To improve students' fluency through the practice of vocabulary and grammar(consolidation of basic grammar knowledge and review of tenses, exercises in writing professional documents and note-taking…) Writing emails/cards/etc., writing announcements and television commercials...

Evaluation method:

Written tests, homework

References:

1. Common European Framework of Reference for Languages: Learning, Teaching, Assessment - Companion volume (2020)

2. English Profile Introducing the CEFR for English (UCLES/CUP 2011)

3. CEFR-informed Learning, Teaching and Assessment: A Practical Guide (2020)

- Detailed program by subject for semester 4

Semester 4

Teaching Unit: UEF 4.1
Subject 1: Applied Thermodynamics
VHS: 90h00 (Course: 1h30, tutorials: 1h30, practical: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives

This course consolidates the thermodynamics knowledge acquired in the first semester of the third year of undergraduate studies (L3) to enable its application in the numerous fields of engineering where it is commonly used. It examines the main updated thermodynamic cycles (Rankine, Hirn, Brayton, Otto, Stirling, Diesel, Atkinson, refrigeration and air conditioning systems, internal combustion engines, turboprop engines and turbojet engines, etc.) and includes other direct energy conversion processes. It also provides an introduction to the analysis of cycle efficiency.

Recommended prior knowledge:

- Basic concepts in general thermodynamics, fluid mechanics, and heat transfer
- Applied Mathematics

Content of the material:

Chapter 1. Properties of Pure Substances
- 1.1. Pure substance
- 1.2. Properties of a pure substance
- 1.3. Phase change of a pure substance
- 1.4. Thermodynamic diagrams
- 1.5. Thermodynamic properties of two-phase systems
- 1.6. Equations of state

Chapter 2. Heat Engines
- 2.1. General information on cycles
- 2.2. Concept of efficiency

Chapter 3. Water Vapor Cycles
- 3.1. Carnot Cycle
- 3.2. Rankine Cycle
- 3.3. Reheating Cycle
- 3.4. Regenerative Cycle
- 3.5. Binary Cycle

Chapter 4. Theoretical Cycles of Internal Combustion Engines

The actual refrigeration unit and heat pump

Chapter 5. Refrigeration cycles and heat pumps
- 5.1. General information on gas engine cycles
- 5.2. Internal combustion piston engines:
  - 5.2.a. Carnot Cycle
  - 5.2.b. Otto Cycle
  - 5.2.c. Diesel Cycle
  - 5.2.d. Mixed cycle
- 5.3. Gas Turbine Installations 5.3.a. Brayton Cycles
  - 5.3.b. Brayton cycles with regeneration
  - 5.3.c. Brayton cycle with intercooling
- 5.4. Jet Engines

Evaluation method:

Written tests, homework assignments, final exam

Bibliographical references:

[1]. MJ Moran, H.,N. Shapiro, “Fundamentals of Engineering Thermodynamics”, 1999, 4th edition Wiley.
[2]. JP Perez “Thermodynamics, Foundations and applications”, Physics Teaching, 2nd edition 1997, Masson.
[3]. Lucien Borel, Daniel Favrat, "Thermodynamics and Energetics - Volume 1, From Energy to Exergy", revised and expanded edition. Publisher: PPUR
[4]. Lucien Borel, Daniel Favrat, Dinh Lan Nguyen, Magdi Batato, “Thermodynamics and Energetics”

Semester 4

Teaching Unit: UEF 4.1
Subject 2: Heat Transfer 1
VHS: 67h30 (Course: 1h30, Tutorials: 3h00)
Credits: 6
Coefficient: 3

Teaching objectives:

To appreciate the heat conductivity of common materials, to evaluate the steady-state heat transfer rates by conduction for common geometries. Applications to rectangular fins. To understand the mechanisms of heat transfer between a fluid and a solid surface.

Recommended prior knowledge:

Thermodynamics, MDF, Mathematics.

Content of the material:

Chapter 1. Introduction of heat transfers and position with respect to thermodynamics. (1 Week)

Chapter 2. Basic Laws of Heat Transfer (1 Week)

Chapter 3. Heat Conduction (5 Weeks)

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

Chapter 4. Heat Transfer by Convection (5 Weeks)

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

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references:

1- JF Sacadura coordinator, “Thermal Transfer: Initiation and Advanced Study”, Lavoisier 2015.

2- Kreith, F.; Boehm, RF; And. al., "Heat and Mass Transfer", Mechanical Engineering Handbook Ed. Frank Kreith,
3- CRC Press LLC, 1999.
4- Bejan and A. Kraus, "Heat Handbook", J. Wiley and sons 2003.
5- F. Kreith and MS Bohn. "Principles of Heat Transfer", 6th ed. Pacific Grove, CA: Brooks/Cole, 2001.
6- YA Cengel, "Heat and Mass Transfer", McGraw Hill.
7- HD Baehr and K. Stephan, "Heat and Mass transfer", 2nd revised edition, Springer Verlag editor, 2006.
8- JL Battaglia, A. Kuzik and JR Puiggali, "Introduction to heat transfer", Dunod 2010.
9- By Giovanni B. Bedat, "Heat transfer", Cépaduès, 2012.
10- JP Holman, "Heat Transfer". 9th ed. New York: McGraw-Hill, 2002.
11- FP Incropera and DP DeWitt. "Introduction to Heat Transfer", 4th ed. New York: John Wiley & Sons, 2002.
12- J. Taine, JP Petit, "Heat transfer and the mechanics of anisothermal fluids", Dunod, 1988.
13- NV Suryanaraya. "Engineering Heat Transfer", St. Paul, Minn.: West, 1995.
14- HD Baehr and K. Stephan, "Heat and Mass transfer", 2nd revised edition, Springer Verlag.

Semester 4
Teaching Unit: UEF 4.1
Subject 3: Energy Conversion

VHS: 22h30(Course: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Apply the concepts of thermodynamics acquired in previous years to various energy-producing or energy-consuming machines. Investigate, through exegetical analysis, the possibilities for improvement or the failures of real thermodynamic systems. Perform energy analysis of systems employing combustion.

Recommended prior knowledge:

Thermodynamics

Content of the material:

Chapter 1. Single-phase power cycles (4 Weeks)

Definitions. Carnot cycle. Otto cycle. Diesel cycle. Mixed cycle. Joule-Brayton cycle. Ericsson cycle. Stirling cycle. - Preheat or regenerator cycle - Multistage cycle with regenerator, cooling, and intermediate reheating. Different components of a gas-fired power plant.

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

Review of phase changes. Rankine cycle. Hirn cycle. Reheat cycle. Cycle with one or more steam draws. Mixed cycle (gas-condenser). Steam power plants. Hybrid plants (solar-gas). Cogeneration plants. Basic information on nuclear power plants.

Chapter 3. Exergy and exergetic analysis of thermodynamic systems (2 Weeks)

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

Chapter 4. Thermodynamics of Combustion (2 Weeks)

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

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references:

1- RE Sonntag and JG Van Wylen, “Fundamentals of classical thermodynamics”, Ed. J. Wiley & Sons, 1978.

2- Kaster, "Thermodynamics 6th edition", Masson, 1968.
3- R. Kling, "Thermodynamics and application", Technip Edition.
4- M. Bertin, JP Faroux and J. Renault, "Thermodynamics", Dunod Université, 1981.
5- MW Zemansky and RH Ditmann, “Heat and Thermodynamic”, 7th edition, McGraw Hill, 1981.
6- JP Perez, "Thermodynamics, Foundations and Applications", second edition, 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 4
Teaching Unit: UEF 4.2
Subject 1: Strength of Materials

VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practicals: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:

To know the methods of calculating the resistance of structural elements and to determine the variations in the shape and dimensions (deformations) of the elements under the action of loads.

Recommended prior knowledge:

Analysis of functions; rational mechanics.

Content of the material:

Chapter 1: INTRODUCTION AND GENERALITIES (2 weeks)

1.1 Goals and assumptions of strength of materials
1.2 Classification of solids (beam, plate, shell)
1.3 Different types of loads
1.4 Connections (supports, fixed joints, ball joints)
1.5 General Principle of Equilibrium – Equations of Equilibrium
1.6 Cutting Principles – Reduction Elements
1.7 Definitions and sign conventions for:
- Normal effort N,
- Shear force T,
- Bending moment M

Chapter 2: Traction and Compression (3 weeks)

2.1 Definitions
2.2 Normal tensile and compressive stress
2.3 Elastic deformation in tension/compression
2.4 Tensile/Compressive Strength Condition

Chapter 3: SHEAR (2 weeks)

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

Chapter 4: GEOMETRIC CHARACTERISTICS (3 weeks)

STRAIGHT SECTIONS
4.1 Static moments of a cross section
4.2 Moments of inertia of a cross-section
4.3 Formulas for transforming moments of inertia

Chapter 5: TWIST (2 weeks)

5.1 Definitions
5.2 Tangential or shear stress
5.3 Elastic torsional deformation
5.4 Torsional resistance condition

Chapter 6: Simple Plane Flexion (3 weeks)

6.1 Definitions and assumptions
6.2 Shear forces, bending moments
6.3 Shear force and bending moment diagram

6.4 Relationship between bending moment and shear force
6.5 Deformation of a beam subjected to simple bending (deflection)
5.6.6 Stress calculation and dimensioning

Lab content:

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

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references:

1- Mechanics for Engineers – Statics. Ferdinand P. Beer and Russell Johnston, Jr., McGraw-Hill, 1981.
2- Strength of materials, P. STEPINE, MIR Editions; Moscow, 1986.
3- Strength of Materials 1, William A. Nash, McGraw-Hill, 1974.
4- Strength of Materials, S. Timoshenko, Dunod, 1986

Semester 4
Teaching Unit: UEF 4.2
Subject 2: Hydraulics and Pneumatics
VHS: 45h00 (Course: 1h30, Tutorials: 1h30)

Credits: 4
Coefficient: 2

Teaching objectives:

The objective of the program is to provide students with a set of essential knowledge necessary for the physical understanding of the core of hydraulic and pneumatic systems.

Recommended prior knowledge:

Knowledge of fluid mechanics and thermodynamics

Content of the material:

Chapter 1: Introduction and background (2 weeks)

Hydraulic fluids: different types of hydraulic fluids, mineral oil, synthetic oil, and aqueous products; characteristics of hydraulic fluids. Viscosity: the influence of temperature and pressure on viscosity. Flow regime, Reynolds number, pressure losses. Filtration. Intake air quality: air humidity, air contamination by solid particles, different types of air filters.

Chapter 2: Pumps and compressors (4 weeks)

Positive displacement pumps and compressors: classification, axial piston pumps, radial piston pumps, vane pumps, gear pumps, screw pumps. Hydraulic and pneumatic motors: general information, motor classification, axial piston motors, radial piston motors, gear motors, vane motors, slow-speed cam and roller motors.

Chapter 3: Cylinders (2 weeks)

Cylinders, classification, single-acting return cylinder, single-acting cylinder, single double-acting cylinder, differential double-acting cylinder, double-rod double-acting cylinder, telescopic cylinder, rotary cylinder, cylinder stiffness, stiffness expression, calculation example, end-of-stroke damping, rod buckling.

Chapter 4: Hydraulic Pipelines (3 weeks)

Pipelines, rigid pipes, materials, dimensions, flexible pipes. Pressure regulation, direct-acting pressure relief valves, indirect-acting pressure relief valves, pressure reducers. Flow control, flow limiters, flow regulators, check valves. Distributors, accumulators, applications. Studies of hydraulic and pneumatic systems.

Chapter 5: Practical Examples (3 weeks)

- Control of a pneumatic motor
- Control of a two-way rotating hydraulic motor
- Adjusting the speed of a cylinder
- Construction of a hydraulic circuit

Chapter 6: Simulation software **(1 week)**

Software for simulating hydraulic and pneumatic systems (Automation-Studio-Hydraulics etc…)

Evaluation method:

Written tests, homework assignments, final exam.

Bibliographical references

1. J. Faisandier: Hydraulic and electrohydraulic mechanisms. Dunod Publishing, 2006
2. Fawcett. Applied hydraulics and pneumatics in industry. Trade and Technical Press Ltd, 2009.

3. Gille, Décanule Pellegrin. Theory and technique of servomechanisms, Dunod
4. J. PheasantHydraulic and pneumatic mechanisms, Collection:Technology and Engineering,Dunod/L'Usine Nouvelle2013 - 9th edition
5. *José Roldanveloria. Help*-Industrial Hydraulics Thesis. Dunod 2004
6. www.thierry-lequeu.fr/data/99ART147.HTM

Semester 4
Teaching Unit: UEF 4.2
Subject 3: Measurement and Instrumentation
VHS: 45h00 (Course: 1h30, Practical: 1h30)

Credits: 3
Coefficient: 2

Teaching objectives:
Acquire various experimental and measurement techniques, particularly those used in energy. Learn to choose the right instruments and sensors to set up your own experiments. Be able to recognize and appreciate errors.

Recommended prior knowledge:
Thermodynamics, MDF, electricity…

Contents of the material:

Chapter 1. Measuring Thicknesses and Lengths (5 Weeks)
Mechanical instruments, pneumatic instruments, optical instruments, error assessment.

Chapter 2. Temperature Measurements (5 Weeks)
Thermocouples, thermistors, infrared detectors, pyrometers. Calibration of thermal sensors. Errors related to thermal sensors. Sensor selection. Automatic measurement acquisition and acquisition cards.

Chapter 3. Measurements of flow rates, velocities and pressures (5 Weeks)
Flow measurement: The different flow meters, The choice and errors related to each type, Pitot, Präsil and Prandtl tubes.
Pressure measurements: Mechanical sensors, piezoelectric sensors. Electrical measurements, signal processing, interpretation of results.
The development of the experiments.

Practical exercises.
Depending on the resources of the establishment and the availability of equipment, a minimum of five (05) practical sessions must be carried out in this subject.

Evaluation method:
Written tests, homework assignments, final exam.

Bibliographical references:
1. RJ Goldstein, "Fluid Mechanics Measurements", 1983.
2. JO Hinze, "Turbulence", Mc Graw-Hill Book Cie, Inc, 1975.
3. E. Guyon, JP Hulin and L. Petit, "Physical Hydrodynamics", CNRS Ed. 2001.

Semester 4
Teaching Unit: UEM 4.1
Subject 1: Numerical Methods

VHS: 45h00 (course: 1h30, Practical: 1h30)
Credits: 2
Coefficient: 2

Teaching objectives:

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

Recommended prior knowledge:

Math 1, Math 2, Computer Science 1 and Computer Science 2

Content of the material:

Chapter 1: Solving nonlinear equations f(x)=0 **(3 weeks)**

1. Introduction to calculation errors and approximations,
2. Introduction to methods for solving nonlinear equations,
3. Bisection method,
4. Method of successive approximations (fixed point),
5. Newton-Raphson method.

Chapter 2: Polynomial Interpolation **(2 weeks)**

1. General Introduction,
2. Lagrange polynomial,
3. Newton's polynomials.

Chapter 3 Function Approximation: **(2 weeks)**

1. Approximation method and root mean square.
2. Orthogonal or pseudo-orthogonal systems. Approximation by orthogonal polynomials

3. Trigonometric Approximation

Chapter 4: Numerical Integration **(2 weeks)**

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

Chapter 5: Solving ordinary differential equations (the initial condition or Cauchy problem) **(2 weeks).**

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

Chapter 6: Direct Method for Solving Systems of Linear Equations **(2 weeks)**

1. Introduction and definitions,
2. Gauss's method and pivoting,
3. LU factorization method,
4. Choeleski MMt factorization method,
5. Thomas Algorithm (TDMA) for tri-diagonal systems.

Chapter 7: Approximate Method for Solving Systems of Linear Equations **(2 weeks)**

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

Content of the practical exercises:

1. Solving nonlinear equations
   1.1. Bisection Method
   1.2. Fixed-point method

1.3. Newton-Raphson Method

2. Interpolation and approximation
   2.1. Newton's Interpolation
   2.2. Chebyshev approximation
3. Numerical Integrations
   3.1. Rectangle Method
   3.2. Trapezoidal Method
   3.3. Simpson's Method

4. Differential equations
   4.1. Euler's Method
   4.2. Runge-Kutta Methods

5. Systems of linear equations
   5.1. Gauss-Jordan Method
   5.2. Crout decomposition and LU factorization
   5.3. Jacobi's Method
   5.4. Gauss-Seidel Method

Evaluation method:
Written tests, homework assignments, final exam.

Bibliographical references:

1. BREZINSKI (C.), Introduction to the practice of numerical calculation. Dunod, Paris (1988).
2. G. Allaire and SM Kaber, 2002. Numerical linear algebra. Ellipses.
3. G. Allaire and SM Kaber, 2002. Introduction to Scilab. Practical exercises with solutions. Linear algebra. Ellipses.
4. G. Christol, A. Cot and C.-M. Marle, 1996. Differential Calculus. Ellipses.
5. M. Crouzeix and A.-L. Mignot, 1983. Numerical analysis of differential equations. Masson.
6. S. Delabrière and M. Postel, 2004. Approximation methods. Differential equations. Scilab applications. Ellipses.
7. J.-P. Demailly, 1996. Numerical Analysis and Differential Equations. Presses University of Grenoble, 1996.
8. E. Hairer, SP Norsett and G. Wanner, 1993. Solving Ordinary Differential Equations, Springer.
9. CIARLET (PG). Introduction to numerical matrix analysis and optimization. Masson, Paris (1982).

Semester 4
Teaching Unit: UEM 4.1
Subject 2: Computer-Aided Design

VHS: 22h30(practical: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

This course will enable students to acquire the principles of representing parts in technical drawing. Furthermore, this subject will allow students to represent and read blueprints.

Recommended prior knowledge

Technical Drawing

Content of the material:

Chapter 0: Review of technical drawing (3 weeks)

1- Cross-section views
2- Developments and intersections
3- Assembled drawing
4- Geometric drawings and connections
5- Cups

Chapter 1: PRESENTATION OF THE CHOSEN SOFTWARE (2 weeks)
(SolidWorks, Autocad, Catia, Inventor, etc..)

1.1 Introduction and history of CAD
1.2 Configuration of the chosen software
1.3 Software reference materials (software help, tutorials, etc.)
1.4 Saving files (part file, assembly file, drawing file, saving procedure for submission to the teacher)
1.5 Communication and interdependence between files.

Chapter2: CONCEPT OF SKETCHES (3 weeks)

2.1 Sketching tools (point, line segment, arc, circle, ellipse, polygon, etc.);
2.2 Sketch relations (horizontal, vertical, equal, parallel, collinear, fixed, etc.);
2.3 Dimensioning of sketches and geometric constraints.
2.4 3D Modeling (Part 1)

Chapter 3. 3D MODELING (3 weeks)

3.1 Concepts of planes (front plane, right plane and top plane)
3.2 Basic functions (extrusion, material removal, revolution)
3.4 Display functions (zoom, multiple views, multiple windows, etc.)
3.5 Editing tools (Delete, Offset, Copy, Mirror, Trim, Extend, Move)
3.6 Creating a cross-sectional view of the model.

Chapter 4: CREATING THE 3D MODEL (2 weeks)

4.1 Editing the plan and the title block
4.2 Choice of views and layout
4.3 Object Skins and Properties (The hatching, dimensions, text, tables, etc...

Chapter 5: ASSEMBLIES (2 weeks)

5.1 Assembly constraints (parallel, coincident, coaxial, fixed, etc.):
5.2 Creation of assembly drawings
5.3 Assembly drawing and parts list
1. Exploded view.

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references:

1- Solidworks bible 2013 Matt Lombard, Wiley Edition.
2- Technical drawing, Saint-Laurent, GIESECKE, Frederick E. Éditions du renouveau pédagogique Inc., 1982.
3- Exercises in drawing mechanical parts and assemblies with SolidWorks software, Jean Louis Berthéol, François Mendes.
4- CAD accessible to all with SolidWorks: from creation to realization volume 1 Pascal Rétif.
5- Guide for industrial draftsmen, Chevalier A, Hachette Technique Edition.

Semester 4
Teaching Unit: UED 4.1

Subject 1: Energy Production and Transport
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

To raise students' awareness of global energy issues. To provide general knowledge about the main energy production and transport systems.

Recommended prior knowledge:

Thermodynamics, Basic concepts of electricity.

Content of the material:

Chapter 1: Energy Production and Conversion (8 weeks)

1. Thermal steam power plants and gas turbines.
2. Diesel engine generator sets.
3. Principle of converting solar energy into electrical energy.
4. Photovoltaic power plants.
5. Nuclear power plants,
6. Hydroelectric and wind power plants.
7. Geothermal and tidal power plants.

Chapter 2: Transport of electrical energy (4 weeks)

1. Models of electrical network elements.
2. Analysis of networks in steady state.
3. Voltage and frequency adjustment.
4. Automatic generator control.

Chapter 3: Distribution of electrical energy (3 weeks)

1. Architecture of HV, MV and LV networks.
2. MT distribution substation.
3. Low voltage distribution substation.

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references:

1- Advanced Thermodynamics for Engineers Oxford Amsterdam Boston London New York Paris, Butterword Heinemann, 1997
2- Energy Systems, Renaud Gicquel, Les Presses, 2009
3- Engineering Technique B1, Boilers, Jean Jacques Baron.

Semester 4
Teaching Unit: UET 4.1

Subject 1: Information, Expression and Communication Technology
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

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

Recommended prior knowledge:

Languages (Arabic; French; English)

Content of the material:

Chapter 1: Researching, analyzing and organizing information (3 weeks)
Identify and use locations, tools and documentary resources, Understand and analyze documents, Create and update documentation.

Chapter 2: Improving Expression Skills (3 weeks)
Consider the communication situation, produce a written message, communicate orally, produce a visual and audiovisual message.

Chapter 3: Improving communication skills in interaction situations (3 weeks)
Analyze the interpersonal communication process, improve face-to-face communication skills, improve group communication skills.

Chapter 4: Developing autonomy, organizational and communication skills within a project-based approach (6 weeks)
To situate oneself within a project and communication approach, To anticipate action, To implement a project: Presentation of a report of a practical work (Homework).

Evaluation method:

Quizzes, homework assignments, final exam

Bibliographical references:

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

Detailed course syllabi for semester 5

Semester: 5
Teaching Unit: UEF 5.1 IGMF 5.1
Subject: Mechanical Construction 1
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

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

Recommended prior knowledge:

Industrial drawing, strength of materials, mechanical manufacturing processes.

Contents of the material:

Chapter 1. Introduction (2 weeks)
Generalities (Mechanical construction, Design study, Safety coefficient, Standards, Economics, Reliability).

Chapter 2. Threaded Assemblies (3 weeks)
Screws, bolts, studs, resistance calculation (shear, sagging, bending, tightening of a statically indeterminate system)

Chapter 3. Non-removable assemblies (4 weeks)
Riveting (different types of rivets and rivets, dimensioning calculations, etc.)
Welding (Different types of welds, Weld calculations: butt welds, lap welds, cover welds, cylindrical welds, dynamic load welds, etc.)

Chapter 4. Assembly of parts by press fit (3 weeks)
Introduction, Advantages, Disadvantages, resistance calculation (axial load, torsional moment).
Hub heating assembly, shaft cooling assembly, adjustment calculation.

Chapter 5. Elements of Obstacles (3 weeks)
Keys, splines and springs (dimensioning and strength calculations)

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. Buchet Jean David Morvan, "The Gears", Ed. Delcourt G. Productions01/2004.
2. Georges Henriot, "The Gears", Ed. Dunod.
3. Alain Pouget, Thierry Berthomieu, Yves Boutron, Emmanuel Cuenot, "Structures and mechanisms - Mechanical construction activities", Ed. Hachette Technique.

4. R. Quatremer, JP Trotignon, M. Dejans, H. Lehu, “Précis de Construction Mécanique”, Tome 1, Projets-études, composés, normalisation, Afnor, Nathan 2001.
5. R. Quatremer, JP Trotignon, M. Dejans, H. Lehu. “Précis de Construction Mécanique”, Volume 3, Projects-calculations, dimensioning, normalisation, Afnor, Nathan 1997.
6. Youde Xiong, Y. Qian, Z. Xiong, D. Picard. Formulaire de mécanique, Pièces de construction, Eyrolles, 2007.
7. Jean-Louis Fanchon. "Guide to Mechanics", Nathan, 2008.
8. Francis Esnault, “Mechanical Construction, Power Transmission”, Volume 1, Principles and Eco-design, Dunod, 2009.
9. Francis Esnault, "Mechanical Construction, Power Transmission", Volume 2, Applications, Dunod, 2001.
10. Francis Esnault, "Mechanical Construction, Power Transmission", Volume 3, Power Transmission by Flexible Links, Dunod, 1999.
11. Bawin, V. and Delforge, C., “Mechanical Construction”, Original edition: G. Thome, Liège, 1986.
12. Mr. Szwarcman, "Elements of Machines", Lavoisier edition 1983
13. WL Cleghorn, “Mechanics of machines”, Oxford University Press, 2008.

Semester: 5
Teaching unit: UEF 5.1 IGMF 5.2
Subject 2: Analytical Mechanics
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

This subject equips students with the necessary tools to analyze mechanics problems and choose the most appropriate solution method based on the problem's nature, given parameters, and unknowns. The course is divided into two parts: the first part covers rigid body dynamics using classical mechanics, while the second part focuses on analytical mechanics, applying energy principles to solve mechanics problems.

Recommended prior knowledge:

Rational Mechanics, Physics 1, Mathematics

Contents of the material:

Part A:supplementary material on solid mechanics

Chapter 1 Solid Dynamics **(3 weeks)**

Translational motion, rotational motion about a fixed axis, planar motion. Motion of a rigid body about a fixed point in space, Euler's equation, Euler angles, the motion of a rigid body in space. Motion under a central force.

Chapter 2: Elements of Kinetics **(1 week)**

Inertia tensor. Kinetic energy

Part B: Analytical Mechanics

Chapter 3: Fundamental Concepts **(2 weeks)**

Mechanical links and their classifications, mechanical systems and their classifications, link equation, possible and virtual displacements, degrees of freedom, work of link forces, generalized coordinates and velocities, coordinate transformation equations.

Chapter 4: Principle of Virtual Work **(1 week)**

Chapter 5: D'Alembert's Principle **(1 week)**

Chapter 6: Lagrange Equation of the First Kind **(1 week)**

Chapter 7: Lagrange Equation of the Second Kind **(3 weeks)**

Chapter 8 Hamilton's equation **(3 weeks)**

Hamilton's formalism, Hamilton's equation, Routh's equation.

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. S. Targ, "Elements of Rational Mechanics", Mir Publishers, Moscow.
2. J. Starjinski, “Rational Mechanics”, Mir edition, Moscow.
3. VI Arnold, "The mathematical methods of classical mechanics", Mir Publishers, Moscow.
4. H. Cabannes, “Problems in General Mechanics”, Dunod.
5. M. Combarnous, D. Desjardin & C. Bacon, “Mechanics of solids and systems: Course and corrected exercises”, Dunod.
6. WB Kibble & FH Berkshire, “Classical Mechanics”, 5th Edition, Imperial College Press.
7. G. Kotkine & V. Serbo, “Collection of problems in classical mechanics - answers and solutions”, Mir publishers, Moscow.
8. Jozef HERING, “Course in Mechanics, Analytical Mechanics”, OPU, Algiers, 1993.

Semester: 5
Teaching unit: UEF 5.1 IGMF 5.3
Subject: Industrial Systems Automation
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practical: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:

The assimilation of fundamental knowledge in the field of automation, and the acquisition of the concepts necessary for the control of industrial processes. In general, it is knowing how to define, implement the control rules of a system based on knowledge of the dynamic behavior of the process to be automated and the objectives to be achieved.

Recommended prior knowledge:

Mathematics, regulation, mechanical engineering, electricity…

Content of the material:

Chapter 1:Introduction, control systems, supervisory systems, Manufacturing Execution system (MES). (2 Weeks)

Chapter 2: Automated Systems (Industrial Control and Command) (3 Weeks)

- Introduction
- Objective of industrial systems automation
- Profitability of an automated system
- Life cycle of an industrial system
- Modular design
- Implementation

Chapter 3: Supervisory Application Systems (2 Weeks)

Chapter 4: Structure of Programmable Logic Controllers (4 Weeks)

- The role of an automated system, principles of programmable logic,
- principle of the programmable logic controller (PLC), Implementation technology
- virtual programmable logic controllers (Soft PLCs)

Chapter 05: Industrial Interfaces and Safety Devices (2 Weeks)

TP Automation of industrial systems

Company visits (automated production lines) and practical work, depending on resource availability.

Evaluation method:

Continuous Assessment:40%,Exam :60%.

Bibliographical references:

1. *Henri Bourles. "Linear Systems from Modeling to Control". Editions Lavoisier 2006, Paris.*
2. *Jean Marie Flans. "Industrial Regulation". Hermès 1994; Paris.*
3. *Philippe de Larminat. "Automatic Control of Linear Systems". Hermès Publishers, 1996; Paris*
4. *Patrick Prouvost. "Automation – Control and Regulation", Dunod Edition 2010.*
5. *Yves GRANJON. "Automatic". Dunod Edition 2010*
6. *Olivier Le Gallo. "Automation of mechanical systems". Dunod Publishing, 2009.*
7. *Gérard Boujat, Patrick Anaya. "Industrial Automation", Dunod Publishing, 2007.*
8. *JANET Maurice. "Précis de calcul matriciel et de calcul opérationnelle", Edition Euclide 1982.*
9. *Patrick Prouvost. "Automation – Control and Regulation". Dunod Publishing, 2010.*

Semester: 5
Teaching unit: UEF 5.2 IGMF 5.4
Subject 1: Fracture Mechanics and Fatigue
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The objective of the fracture mechanics course is to provide calculation and analysis methods that enable the optimization of structural design, taking into account the concepts of monitoring, reliability, and cost-effectiveness. It also offers rigorous control of structures susceptible to the unpredictable effects of cracking.

Recommended prior knowledge:

Materials and digital methods.

Contents of the material:

Chapter 1: Structure, materials and properties	**(1 week)**
Chapter 2: Material Fatigue	**(3 weeks)**
Chapter 3: Linear Fracture Mechanics	**(4 weeks)**
Chapter 4: Study of material behavior in the vicinity of a crack	**(4 weeks)**
Chapter: Fatigue Cracking Laws	**(3 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%

Bibliographical references:

1- *RECHO Naman, Mechanics of fracture by cracking - Theoretical, conceptual and numerical aspects, Publisher: Lavoisier, 2012.*
2- *Alain CardouPlasticity, fatigue and fracture of metallic materials: mechanical models, Publisher:Loze-Dion publisher, 2006.*
3- *Dominique François, André Pineau, André Zaoui, Viscoplasticity, damage, fracture mechanics and contact mechanics, Hermes – Lavoisier, 2009.*
4- *Claude BouhelierFracture mechanics, propagation threshold, fatigue crack propagation, Publisher:CETIM – Technical Center for Mechanical Industries, 1989.*
5- *RECHO Naman, Mechanics of crack propagation and bifurcation,HERMES SCIENCE PUBLICATIONS / LAVOISIER, 2012.*
6- *Clément Lemaignan, The Rupture of Materials, Publisher:Edp Sciences, 2003.*
7- Dominique FrançoisDamage and breakage of materials,*Publisher:Edp Sciences, 2004.*

Semester: 5
Teaching unit: UEF 5.2 IGMF 5.5
Subject 2: Crystallography
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practicals: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:

- To acquire the knowledge and skills to deal with theoretical and experimental problems related to the subjects taught in this module.
- Knowing how to use symmetry to explain physical phenomena.
- To enable students to acquire the stereochemistry of classical metallic and ionic structures

Recommended prior knowledge:

Materials Science.

Chapter 1: The different classes of solid matter (3 weeks)

I- What is a solid?
II- Structures of a solid
III- Constituents of a solid

Chapter 2: Crystallography geometry: Basic concepts (2 weeks)

I- Laws and Postulates
II- Internal structures: chemical asymmetric unit; the motif; nodes; network; row; lattice plane; the unit cell.

Chapter 3: Crystallography geometry: Crystal symmetry (2 weeks)

I- Definition and notation of orientation symmetry elements
II- Definition and notation of symmetry elements with translations.
III- Stereographic representation of symmetry elements

Chapter 4: Crystalline Classes & Space Groups (4 weeks)

I- Association of symmetry elements
II- Point groups of symmetry
III- Crystalline Systems
IV- Network Modes
V- Spatial Groups
VI- Concepts of X-ray crystallography: X-ray diffraction; X-ray diffraction technique; Reciprocal grating

Practical exercises

- Crystalline symmetry.
- Metal models
- Ionic models
- X-ray Diffraction

Evaluation method:

Continuous assessment: 40%; exam: 60%.

Bibliographical references:

1. Elements of X-ray crystallography. Publisud. 1990
2. Geometric crystallography and X-ray crystallography: course and solved exercises. Paris: Dunod. 2007
3. Exercises and problems in crystallography. Cépadxués. 2002

Semester: 5
Teaching unit: UEF 5.2 IGMF 5.6
Subject 1: Non-metallic materials
VHS: 22h30(Course: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

To introduce students to the science of non-metallic materials by enabling them to acquire knowledge specific to these materials. Particular attention will be paid to polymer materials, ceramics, and composite materials..

Recommended prior knowledge:

Basic science knowledge acquired in the common core curriculum.

Contents of the material:

Chapter 1 General information on plastics **(2 weeks)**
Structures and properties, Implementation, Standardization.

Chapter 2 Introduction to polymer materials **(3 weeks)**
Nature and structure of polymer materials, The macromolecular chain, Thermoplastic and thermosetting polymers, Elastomers, Amorphous and semi-crystalline polymers, Properties of polymer materials, Mechanical properties, Physical properties, Thermomechanical testing, Long-term behavior (aging), Combustion. Polymer processing. Addition and condensation polymerization.

Chapter 3 Glass and Ceramics **(3 weeks)**
Structure of mineral glasses. Types of ceramics and areas of application. Manufacturing and microstructure of ceramics. Manufacturing and shaping of glasses. Mechanical, electrical, thermal and optical properties. Degradation of ceramics.

Chapter 4 Composite materials **(4 weeks)**
Material combinations and anisotropy. Constituents and their properties. Development, shaping, and properties of different composite families: polymer matrix, metallic matrix, ceramic matrix, and foams. Assembly and machining problems. Mechanical testing. Specific mechanical behavior of composite materials. Calculations: homogenization, mixture laws, constitutive laws, and failure criteria.

Evaluation method:

Exam: 100%.

Bibliographical references:

1. Wilfried Kurz, Jean P. Mercier. "Introduction to Materials Science", 2nd edition, 1991.
2. Marc Carrega et al., “Polymer Materials”. Dunod, 2000.
3. "Treatises on materials, Polymer materials: mechanical and physical properties. Polytechnic and University PressRomandes. 2001.

Semester 5
Teaching Unit: UEM 5.1 IGMF 5.7
Subject: Tutored Project 1
VHS: 45h00 (tutorials: 3h00)
Credits: 2
Coefficient: 2

Define the method for presenting the modules for each Project.
(Methods: Seminars, Conferences, Company visits, mini-projects)

Tutored project 1: Site visit (discovery)
Tutored project 2: seminar, study day
Tutored Project 3: Mini-project 1 (with presentation)
Tutored Project 4: Mini-project 2 (with presentation)
Tutored Project 5: Site Visit (Production Line)
Tutored project 6: Individual presentation (on one of the topics mentioned).

Topics:

- System reliability
- Industrial maintenance and safety.
- Business creation and procedures
- Introduction to Artificial Intelligence
- Introduction to innovation
- Non-destructive testing
- Repairs and Interventions
- Eco-Manufacturing
- Sensors and measurement techniques
- Tribology and lubrication of mechanical systems
- Quality Management
- Industrial risks and safety techniques
- Human factors
- 3D printing

Semester: 5
Teaching Unit UEM 5.1 IGMF 5.8
Subject: Maintenance Organization and Methods
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
This program allows the student to acquire the necessary training on the organization of maintenance within a company, cost management methods and inventory management.

Recommended prior knowledge:
Basic concepts in maintenance, laws of probability.

Content of the material:

Chapter 1: **Maintenance organization** **(3 weeks)**
The role of maintenance within the overall structure - Internal organization of maintenance - Human resources - Material resources

Chapter 2: Maintenance costs: **(6 weeks)**
-Cost composition -Cost analysis and ABC method -Optimal preventive maintenance - Example of MTBF calculation - Optimization of replacement using the probability model - Choice between maintenance and replacement - Economic life -Decommissioning of equipment.

Chapter 3: Inventory and Supply Management **(4 weeks)**
System catalog, reading installation diagrams,

Chapter 4: Use of computer tools in maintenance **(2 weeks)**
Computer-aided maintenance management; Introduction and example of execution.

Evaluation method:

Exam: 100%.

Bibliographical references:

1- François Manchy, Jean Pierre Vernier: Maintenance: methods and organizations. 3rd edition DUNOD;
2- *Jean-Claude Francastel Maintenance Engineering: From the design to the operation of an asset, Publisher(s):Dunod,The New Factory, Collection :Technology and Engineering - Industrial Management, 2009.*

Semester: 5
Teaching Unit: UEM 5.1 IGM 5.9
Subject: Preventive Maintenance
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
To teach the student the objectives of Preventive Maintenance such as: increasing the lifespan of equipment, reducing the probability of failures in service, reducing downtime in case of overhaul or breakdown, how to avoid abnormal consumption of energy, lubricant, improving the working conditions of production staff, reducing the maintenance budget, eliminating the causes of serious accidents, etc.

Recommended prior knowledge:
Machine elements, heat transfer and electrical engineering

Content of the material:

Chapter 1: Types of Preventive Maintenance (2 weeks)
Systematic maintenance, condition-based maintenance, predictive maintenance.

Chapter 2: Implementation of preventive maintenance (4 weeks)
Definition of the systematic, conditional and predictive preventive maintenance plan, definition and integration of monitoring means, planning and implementation of the preventive maintenance plan, use of information collected, updating and optimization of the preventive maintenance plan.

Chapter 3: The different levels of maintenance. (9 weeks)
Simple adjustments not requiring dismantling or opening of the equipment, e.g. Troubleshooting by standard exchange of the components provided for this purpose and minor preventive maintenance operations, e.g. Identification and diagnosis of faults, e.g. All major corrective or preventive maintenance work {with the exception of renovation and reconstruction, e.g. All major renovation, reconstruction or repair work entrusted to a central maintenance workshop or a service provider, e.g.

Evaluation method:
Exam: 100%.

Bibliographical references:
1. Jean Heng. Practical preventive maintenance - 3rd edition: Mechanics. Pneumatics. Hydraulics. Electricity. Refrigeration, 2011.
2. WHO, World Health Organization, UNAIDS. Management, Maintenance and Use Manual: Cold chain equipment for blood, 2008.
3. François Monchy, Jean-Pierre Vernier. Maintenance. Methods and organizations for better productivity. Collection: Technique et Ingénierie, Dunod/L'Usine Nouvelle, 3rd edition, 2012.

Semester: 5
Teaching Unit: UED 5.1 IGMF 5.10
Subject: Recycling and waste recovery
VHS: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Recognizing the basic concepts related to solid waste, its aging, its degradation and the different processes for recovering value from these residues.

Recommended prior knowledge:

Basic science knowledge acquired in the common core curriculum.

Contents of the material:

Chapter I: Definitions and general information on waste and recycling (2 weeks)

Chapter II: Product Life Cycle Analysis (3 weeks)

Chapter III. Waste Recovery (2 weeks)

Chapter IV: Waste Recycling (3 weeks)

Evaluation method:

Exam: 100%.

Bibliographical references:

1. BALET J.-M., "Aide-mémoire de Gestion des déchets", Dunod, 2nd edition, 2008, 248 pages, ISBN 978-2-10-051627-8.
2. -Official Algerian Journal No. 77, December 15, 2001.
3. Brahim Djemaci, "Municipal waste management in Algeria: Prospective analysis and elements of efficiency"; Environmental Sciences. University of Rouen, FRANE, 2012.
4. Abrassart C, "Introduction to Life Cycle Analysis and its applications", course, Polytechnique Montréal, 2011.
5. 5-Abrassard C., Aggeri F., "The birth of eco-design, From product life cycle to environmental product management", Responsibility and Environment, no. 25, Jan. 2002
6. Caillol S., (2008), "Life cycle analysis and eco-design: the keys to a new chemistry", Annales des Mines - Réalités industrielles, November, p.34-41.
7. Butel-Bellini B., Janin M., (1999), "Eco-design: state of the art of available tools", Techniques de l'ingénieur, p.1-12.
8. Puaut M., (2008), "Eco-design: an added value for companies and a future challenge of competitiveness?", Annales des Mines-Réalités industrielles, p.85–93.
9. Matthieu Puigt, "Waste Management. An Introduction", IUT du Littoral Côte d'Opale Professional Bachelor's Degree GRIT, FRANCE. Course. Academic year 2015–2016.
10. Alain Damien, "GUIDE TO WASTE TREATMENT; Regulations and Choice of Processes", 6th edition, Dunod, Paris, 2002, 2004, 2006, 2009, 2013 ISBN 978-2-10-058532-8

11. Denis Bouyer, "Waste treatment, Laboratory of Process Engineering for the development of Bioproducts"; ALIPACK Professional License; University of Montpellier 2.
12. CHENANE A., "Cost Analysis of Household Waste Management in Algeria Through the Issue of Public Landfills: The Case of Municipalities in the Wilaya of Tizi-Ouzou." Faculty of Economics and Management, Mouloud Mammeri University of Tizi-Ouzou
13. Jean-Pierre MICHEL, "Mechanical properties of materials; Selection criteria and methods", BULLETIN OF THE UNION OF PHYSICIANS, École des Mines - Parc de Saurupt - Nancy, France.
14. MOUPELE NG, "Proposal for a waste management plan applicable in developing countries", University of Porto, 2013.9470.
15. Use of waste and by-products in road engineering, Report prepared by a road research group of the OECD (Organisation for Economic Co-operation and Development, Paris, September 1977.

Semester 5
Teaching Unit: UET 5.1 IGMF 5.11
Subject: Technical English related to the specialization
VHS: 22h30(course: 1h30)
Credits: 1
Coefficient: 1

Detailed program by subject for semester 6

Semester: 6
Teaching Unit: UEF 6.1 IGMF 6.1
Subject: Mechanical Construction 2
VHS: 67H30 (Course: 1h30; Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

This subject is a continuation of CM1, it focuses primarily on the sizing calculations of the main motion transmission elements of machines (gears, bearings and shafts etc…), as well as the general technological study of mechanisms (reducer, gearbox, clutches, brakes, etc…).

Recommended prior knowledge:

Rational mechanics Industrial drawing, strength of materials and CM 1.

Contents of the material:

Chapter 1: Gears **(3 weeks)**

Cylindrical gear (spur and helical teeth), bevel gear (spur and helical teeth), worm gear. Dynamic study (surface pressure, breaking strength).

Chapter 2: Trees and Axes **(3 weeks)**

Preliminary calculation of the diameter of the axes and shafts, verification of the shafts and axes for fatigue.

Chapter 3 Motion transmission (calculation and dimensioning) **(3 weeks)**

Plain bearings, bearings and thrust bearings, friction wheels, belts and chains…

Chapter 4: Reducers and Gearboxes **(3weeks)**

Sizing of a speed reducer, Study of a gearbox, Concepts about Epicyclic trains.

Chapter 5: Couplings, clutches and brakes **(3 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. Buchet Jean David Morvan, “The Gears”, Ed.Delcourt G. Productions01/2004.
2. Georges Henriot, “The Gears”, Ed. Dunod.
3. F. Esnault, “Mechanical Construction. Power Transmission”, Volume 3, Ed. Dunod.
4. Alain Pouget, Thierry Berthomieu, Yves Boutron, Emmanuel Cuenot. "Structures and Mechanisms - Mechanical Engineering Activities". Hachette Technique Publishing.
5. R. Quatremer, JP Trotignon, M. Dejans, H. Lehu. "Précis de Construction Mécanique: Projets-études, composés, normalisation", Tome 1, Afnor, Nathan 2001.
6. R. Quatremer, JP Trotignon, M. Dejans, H. Lehu. “Précis de Construction Mécanique : Projets-calculs, dimensionnement, normalisation”, Tome 3, Afnor, Nathan 1997.

Semester: 6
Teaching unit: UEF 3.2.1
Subject 2: Rheology of Materials
VHS: 67h30 (Course: 1h30; Tutorials: 1h30; Practicals: 1h30)
Credits: 5
Coefficient: 32

Teaching objectives:
The subject of rheology provides the student with an opportunity to learn about the behavior of materials over time.

Recommended prior knowledge:
Mechanics of continuous media and Strength of materials.

Contents of the material:

Chapter 1. Introduction (1 Week)
Definitions; Materials and conditions requiring the use of rheological laws to represent material behavior; Normal stress and shear stress. Conventional deformation; Actual deformation. Shear deformation. The stiffness and flexibility modulus of a material. Creep. Relaxation; Recovery; Definitions of fundamental rheological elements (bodies) and their respective behaviors; The Euclidean solid or rigid body; The Hookean solid or linear spring; The Pascalian fluid or perfect fluid; The perfectly plastic St-Venant solid; The Newtonian fluid.

Chapter 2. Linear viscoelastic behavior under uniaxial static loading (3 Weeks)
Definition of the models; Maxwell fluid. Kelvin-Voigt solid. Three-parameter solid (generalized Kelvin-Voigt); Response of the three models to the following tests: Creep; Recovery; Relaxation; Erasure; Tension. Creep flexibility, relaxation modulus, and characteristic time.

Chapter 3. Viscoelastic behavior under cyclic loading (2 weeks)
Response of viscoelastic models to vibrations; Maxwell's model. Kelvin's model.

Chapter 4. Boltzmann's Superposition Principle (1 Week)

Practical work: Rheology of materials
Determination of rheological parameters (viscosity for complex fluids and tests to determine the viscoelasticity of materials (creep and relaxation curves))

Evaluation method:
Continuous assessment: 40%; Examination: 60%.

Bibliographical references:
1. G. Couarraze, JL Grossiord, "Initiation to rheology", Technique et documentation, Lavoisier, 3rd edition (2000).

2. P. Coussot, JL Grossiort, "Understanding Rheology", EDP Sciences (2001)
3. JL Grossiord, P. Coussot, "Understanding Rheology - From Blood Circulation to Concrete Setting", EDP Sciences. 4. CW Macosko, "Rheology: Principles, Measurements, and Applications", Wiley.

Semester 6
Teaching Unit: UEF 6.1 IGMF 6.3
Subject: Heat Treatment
VHS: 45h00 (Course: 1h30, Practical: 1h30)
Credits: 3
Coefficient: 2

Teaching objectives:

- Implement the main heat treatments and experimental techniques for studying the structural transformations of metallic alloys. - Highlight the changes in properties and the valorization of the materials obtained after the treatments.
- To highlight the correlations between behaviors, treatments and structures.

Recommended prior knowledge:

Thermodynamics (understanding of diagrams)'Equilibrium and phase, thermochemistry), basic mechanics. Metals and alloys

Contents of the material:

- ✓ Conventional industrial heat treatments (annealing and quenching, annealing)
- ✓ Thermochemical diffusion treatments (Cementation, Nitriding, etc.)
- ✓ Micrographic observations and measurement of physical and mechanical characteristics
- ✓ Use of professional documents and software (transformation diagrams, heat treatments, characteristic prediction)

(Depending on the resources available at the institution)

The manipulations Each experiment is designed as a project combining the material under study, processing techniques, and characterization. The various experiments address the following themes:

- ✓ Modification of alloy properties by heat treatment throughout the bulk and study of the hardening mechanisms of metallic alloys
- ✓ Predicting the mechanical properties of steels
- ✓ The modification of the surface properties of materials
- ✓ Cold working and the effects of annealing after work hardening

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

A Concise Guide to Metallurgy: Production, Structures-Properties, Standardization / J. Barralis; G. Maeder / AFNOR / 1997 - Industrial Materials: Metallic Materials / M. Colombié / Dunod / 2000 - Metallurgy: Metals, Alloys, Properties / G. Murry / Dunod / 2004 - Metallurgy Volume I: Metallic Alloys / C. Chaussin; G. Hilly / Dunod / 1967 - Basic Principles of Heat, Thermomechanical, and Thermochemical Treatments of Steels / A. Constant; G. Henry; JC Charbonnier / Pyc Edition / 1992 - Elements of Physical Metallurgy T3 to T5 / Adda; Philibert; Quere; Dupouy / CEA / 1988 - Materials Science: Mechanical Metallurgy - From Microscopic to Macroscopic / Cornet; Hlawka / Ellipses / 2006 / Technosup

Semester: 6
Teaching unit: UEF 6.2 IGMF 6.4
Subject: Structural Dynamics
VHS: 45 hours (course: 1h30; tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Mastery of methods enabling the study of displacements and constraints imparted to a given structure subjected to an arbitrary dynamic load.

Recommended prior knowledge:

RDM1, Solving differential equations.

Content of the material:

Chapter 1: Introduction to the dynamics of structures (2 weeks)
Objective of structural dynamics, Characteristics of a dynamic problem, Types of loads, Simple harmonic motions, Vector representation of harmonic motions.

Chapter 2: Forced Vibrations Systems with 1 degree of freedom (4 weeks)
Harmonic excitation, periodic excitation, any dynamic excitation.

Chapter 3: Systems with N degrees of freedom (5 weeks)
Properties of matrices, Calculation of frequencies and modes, Response to excitation.

Chapter 4: Continuous Systems (4 weeks)
Equations of motion, frequencies, modes and orthogonality.

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1- R. Glough, J. Penzien, “Dynamics of structures” Pluralis, 1980.
2- M. Lalanne, P. Berthier, JDHagopian, "Mechanics of linear vibrations", Masson, 1980.
3- SG Kelly, Mechanical Vibrations. “Theory and applications”. Cengage learning, 2012.
4- Thomas Gmür, “Dynamics of Structures - Numerical Modal Analysis”, Presses Polytechniques et Universitaires Romandes, 1997.
5- Patrick Paultre. “Dynamics of structures”,Hermès - Lavoisier, 2005.
6- Samikian A. "Analysis and calculation of structures", Quebec, 1984.
7- ,Studer MA and Frey F. "Introduction to the analysis of structures", Lausanne, 1997.

Clough R. and Penzien JA, "Dynamics of Structures", second edition, C. Berkeley, 2004

Semester 6
Teaching unit: UEF 6.2 IGMF 6.5
Subject: Theory of Mechanisms
VHS: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The content of this course will enable students to undertake an analysis or synthesis study of mechanical systems. At the undergraduate level, three essential parts are covered: (i) a mathematical review of the essential mathematical tools necessary for the study of mechanisms (screws, cross product, co-moment, linear systems, etc.); (ii) a thorough reading of a mechanical system diagram in order to identify equivalence classes, contact graphs, normalized mechanical joints, minimal schematic representation, and classification of mechanisms; and (iii) static and kinematic studies of parallel joints. serial connections and chains closed.

Recommended prior knowledge:

Vector analysis, industrial drawing, general technology, mechanical manufacturing and rational mechanics. Algebra: Matrices, linear systems and matrix operations.

Contents of the material:

Chapter 1: Preliminary Information and Background (3 weeks)

Concept of the wrench and its characteristics, Definitions and assumptions: Machine. Mechanisms. Kinematic chain. Fixed element or frame. Kinematic linkage/couple. Planar mechanisms. Spherical mechanisms. Spatial mechanisms. Examples of mechanisms. Common mechanical links.

Chapter 2: Modeling of mechanisms (3 weeks)

Graph associated with a mechanical system. Kinematic chains and diagrams of a mechanical system.

Chapter 3 Mobility and hyper staticity of a mechanism (5 weeks)

Definitions: Kinematic and static analysis of parallel links, Kinematic and static analysis of series links, Kinematic and static analysis of closed chains, Systematic search for isostatic solutions.

Chapter 4 Kinematic analysis of planar mechanisms (3 weeks)

Definition of a planar mechanism, Identification of the parameters of a planar mechanism, Grashoff's laws for 4-bar articulated mechanisms, Analysis of the displacements of a planar mechanism (Graphical method, Analytical method, Case study).

Chapter 5Introduction to CAD and synthesis of mechanisms (1 week)

Design of an isostatic mechanism using CAD software (solidworks), Simulation on the Cosmos Motion Module.

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. Marc Rossetto and Pierre Agati. Liaison, "Mechanisms and Assembly". 2nd edition, Collection science Sup. Dunod, 2001.
2. Michel Aublin, René Boncompain. "Mechanical Systems. Theory and Dimensioning", Science Sup Collection. Dunod, 2005.
3. Marc Rossetto and Pierre Agati. “Links and Mechanisms”. Dunod, 1994.
4. Patrick Beynet. "Industrial Sciences for Engineers". Ellipse Publishing Marketing SA, 2012.
5. ViguenArakelian. “Structure and kinematics of mechanisms”, Hermes, 1997.
6. Artobolovsky II “Theory of Mechanisms and Machines”, Moscow Science Publishing House, 1988.
7. R. le Borzec and J. Lotterie. "Principle of the Theory of Mechanisms", Dunod edition, 1977.
8. Boudet- C. Bortolussi. “Presentation of the mechanisms”, Techniques de l'ingénieur- B 600/8600,1 – R. 1980.
9. Jean-Louis Fanchon.Guide to Industrial Science and TechnologyEditionDunod,2014.
10. HUNT KH"Kinematic geometry of mechanisms. EdtClordon Press Oxford, 1978.

Semester: 6
Teaching unit: UEF 6.2 IGMF 6.6
Subject 3: Internal Combustion Engines
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practical: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:

Understanding the operation of different types of internal combustion engines from both a thermodynamic and mechanical perspective.

Recommended prior knowledge:

Thermodynamics and mathematics.

Content of the material:

Chapter 1. General Information (2 Weeks)

Operating principle and classification of heat engines, Fuels for internal combustion engines.

Chapter 2. The Thermodynamics of Engine Cycles (4 Weeks)

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

Chapter 3. Actual Cycle of an Internal Combustion Engine (4 Weeks)

Intake, Compression, Combustion, Expansion, Exhaust, The parameters indicated, The actual parameters, Construction of the theoretical diagram indicated.

Chapter 4. Dynamics of reciprocating engines (3 Weeks)

Crank-connecting rod system: Kinematic study – Dynamic study. Distribution system: Kinematic study – Dynamic study. Balancing.

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

Performance parameters, standards, characteristics: Full load - partial loads - universal.

Practical Exercises:

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

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. JB Heywood, “Internal Combustion Fundamentals”, McGraw Hill Higher Education, 1989.
2. P. Arquès, “Design and construction of alternative engines”, Ellipse, 2000.
3. JC. Guibet, “Fuels and engines”, 1997.
4. P. Arquès, “Reciprocating Internal Combustion Engines (Technology)”, Masson edition, 1987.

5. UY FaminGorban, AI, Dobrovolsky VV, Lukin AI et al., “Marine internal combustion engines”, Leningrad:Sudostrojenij, 1989, 344p.
6. W. Diamant, “Internal combustion engines”, ECAM, 1984.
7. M. Desbois, R. Armao, "The diesel engine, Foucher Edition", Paris, 1974.
8. M. Menardon, D. Jolivet, “Les moteurs, Edition Chotard”, Paris, 1986.
9. Mr. Desbois, "The automobile: T1: 4-stroke and two-stroke engines. T2: Transmission and operating components", Chotard Edition, 1989.
10. P. Arques, “Combustion”, Ellipses, Paris, 1987.
11. H. Memetau, “Functional techniques of the automobile: The Engine and its auxiliaries”, Dunod, Paris, 2002.

Semester 6
Teaching Unit: UEM 6.1 IGMF 6.7
Subject: Company Internship 1
VHS: Over-quota hourly volume
Credits: 1
Coefficient: 1

Semester: 6
Teaching Unit: UEM 6.1 IGMF 6.8
Subject: Troubleshooting and fault management
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
This program allows the student to train in methods of diagnosing mechanical and energy installations as well as assisted failure management.

Recommended prior knowledge:
Basic knowledge of maintenance, knowledge of energy installations.

Content of the material:

Chapter 1 Troubleshooting and Fault Detection **(2 weeks)**
Introduction to diagnosis, expertise and prognosis.

Chapter 2: Anomaly Detection **(4 weeks)**
Wear and lubrication, greasing, corrosion and surface condition.

Chapter 3: Fault Management **(3 weeks)**
The detection and management of faults in a mechanical or energy installation, the diagnosis, prognosis and intervention on a system.

Chapter 4: Maintenance Monitoring **(4 weeks)**
Maintenance log, incident report, history log. Technical documents for energy systems, reading and/or writing a technical maintenance report

Chapter 5: Use of IT tools in the DGP **(2 weeks)**
Introduction to computer-aided maintenance management tools; Introduction and example of execution.

Evaluation method:
Exam: 100%.

Bibliographical references:
1- *Jean-Claude Francastel Maintenance Engineering: From the design to the operation of an asset, Publisher(s): Dunod, The New Factory, Collection :Technology and Engineering - Industrial Management, 2009.*
2- F. Castellazi, D. Cogniel, Y. Gangloff: Memotech Industrial Maintenance. Published by ELeducalivre

Semester 6
Teaching Unit: UED 6.1 IGMF 6.9
Subject: Logistics and inventory management
VHS: 22h30(course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

This course should introduce students to:

- Logistics,
- The materials distribution and management network,
- Supply chain management and just-in-time delivery,
- Inventory systems in a context of independent and dependent demand,
- Material requirements planning,
- The evaluation of supply and inventory systems,
- Various analytical models.

Recommended prior knowledge:

None

Content of the material:

Chapter 1: The supply chain (4 weeks)

- Introduction

Evaluating the performance of a supply chain: the reverse supply chain, the green supply chain

- Forecasting models

Time series, seasonal indices, impact on the planning process

- Decisions regarding the location of storage facilities and their internal layout

The location of a deposit, La comparison of the location of several deposits, the choice of a location through a network

Chapter 2: Inventory management models (5 weeks)

- Quantities to be ordered per order, constant and/or variable manufacturing/delivery time and/or demand
- Safety stock levels, shortage cost, service levels, selection criteria
- Key points of batching
- Determining batch sizes with multiple products

Quantity discounts

- Newsboy Model
- Simulation

Chapter 3: Inventory Management Models (1 week)

- Inputs, outputs, product nomenclature, comparisons with QEC, capacity, batch size formation

Chapter 4: Transportation (2 weeks)

- Direct transport models
- Transshipment models

Chapter 5: Supplier Selection and Procurement Management (2 weeks)

The purchasing process

- The "risk/value" technique for determining the importance of purchased products
- Criteria and models for selecting suppliers

Chapter 6: Information Systems and the Supply Chain (1 week)

- E-commerce and inventory management in a supply chain

Evaluation method:

Continuous assessment: 100%.

Bibliographical references:

1. Required reading: Lakhal, Salem Y. (2003), Management Inventoriers in a Supply Chain: Strategy, Planning and Models, published by Prentice Hall. ISBN: 0-536-77504-4

2. Software: a. Excel files, by C.DesRochers, available on the network if needed b. Specialized software as needed (WinQSB, Crystal Ball, Simulation, etc.

Semester 6
Teaching Unit: UET 6.1 IGMF 6.10
Subject: Entrepreneurship and Start-ups
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

- Preparing for professional integration upon completion of studies;
- Developing entrepreneurial skills among students;
- To raise awareness among students and familiarize them with the opportunities, challenges, procedures, characteristics, attitudes and skills required for entrepreneurship;
- To prepare students so that they can, one day, create their own business or, at least, better understand their work in an SME.

Recommended prior knowledge:

No special knowledge is required, except for proficiency in the language of instruction.

Skills targeted:

Ability to analyze, synthesize, work in a team, communicate effectively both orally and in writing, work independently, plan and meet deadlines, and be both responsive and proactive. An introduction to entrepreneurship through a presentation of management knowledge useful for starting a business.

Contents of the material:

Chapter 1 – Operational readiness for employment: **(2 Weeks)**

Writing cover letters and preparing CVs, job interviews, documentary research on industry jobs, conducting interviews with industry professionals and mock job interviews.

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

Entrepreneurship, Businesses around you, Entrepreneurial motivation, Setting goals, Taking risks

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

The qualities of an entrepreneur, Negotiation skills, Listening skills, The role of SMEs and micro-enterprises in Algeria, The main success factors when creating a micro-enterprise/SME

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

Creativity and innovation, recognizing and evaluating business opportunities

Chapter 5 – Starting and Running a Business: **(3 Weeks)**

Choosing a suitable market, Choosing a business location, Legal structures for the business, Seeking help and funding to start a business, Recruiting staff, Choosing suppliers

Chapter 6 - Developing the business plan: **(3 Weeks)**

The Business Model and the Business Plan: Realizing your business project with the Business Model Canvas

Evaluation method: Exam: 100%

References:

- FayolleAlain, 2017. Entrepreneurship: Theories and Practices, Applications for Learning to Undertake. Dunod, 3rd ed.

- LégerJarniou, Catherine, 2013, The Entrepreneur's Big Book. Dunod, 2013.

- Plane Jean-Michel, 2016, Management of organizations: theories, concepts, performance. Dunod, 4th ed.

- LégerJarniou, Catherine, 2017, Building Your Business Plan: The Entrepreneur's Handbook. Dunod.

- Sion Michel, 2016, Succeeding in your business: Methods, tools and tips plan. Dunod, 4th ed.

- Patrick Koenblit, Carole Nicolas, Hélène Lehongre, Building your professional project, ESF, Publisher 2011.

- Lucie Beauchesne, Anne Riberolles, Building your professional project, L'Etudiant 2002.

- ALBAGLI Claude and HENAULT Georges (1996), Business creation in Africa, ed EDICEF/AUPELF, 208 p.

Semester 6
Teaching Unit: UET 6.1 IGM 6.11
Subject: Introduction to Industrial Property
VHS: 22h30(course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The course covers the conditions and scope of protection afforded to trademarks, patents, designs, and literary and artistic works. It also addresses the relationship with unfair competition law.

Recommended prior knowledge:

None

Content of the material:

- Introduction
- Intellectual property
  The two branches of intellectual property
- Patents for invention
- Utility models
- Industrial designs and models
- Intellectual property and integrated circuits
- Brands
- Trade names
- Geographical indications
- Protection against unfair competition

Evaluation method:

Continuous assessment: 100%.

Bibliographical references

Understanding Industrial Property, ISBN: 978-92-805-2589-2. World Intellectual Property Organization.

Detailed program by subject for the semester7

Semester 7
Teaching Unit: UEF 7.1 IGMF 7.1
Subject: Finite Element Method
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practical: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:

To present the finite element method and modern solution methods that allow us to deal with linear and nonlinear problems, one- and two-dimensional field problems, non-stationary field problems and solid mechanics problems.

It is primarily intended for students who wish to develop comprehensive skills in finite element methodology, from fundamental concepts to practical computer implementations.

Recommended prior knowledge:

Concepts in: Continuum Mechanics, Variation Formulation, Matrix Calculus, Differential Calculus, Numerical Analysis.

Content of the material:

Chapter 1: Basic Concepts **(2 weeks)**

1-Introduction to the finite element method
2- Deformation energy.
3- Matrix analysis methods
4- Principle of virtual work
5-Variational Principle
6- Galerkin Method (Weighted Residuals)

Chapter 2: Linear Elements of Structures **(2 weeks)**

1- Linear and spiral spring elements.
2- Elastic Bar Elements
3- Winch system
4- Beam Elements

Chapter 3: Elements of Two-Dimensional Structures **(3 weeks)**

1- Introduction
2- Plane stresses, plane strains, and stress-strain relationships
3- Triangular and rectangular plane elements (of order 1: T3 and Q4 and of higher order: T6 and Q8)
4- Isoperimetric formulation of the quadrilateral element
5- Elements for plate bending (ACM, R4)

Chapter 4: Elements of Three-Dimensional Structures **(3 weeks)**

1. Introduction
2. Tetrahedral elements (4, 10 and 20 nodes)
3. Solid Elements (8-node bricks)
4. Isoperimetric formulation of volume elements
5. Analysis of three-dimensional structures using planar elements.

6. Solid of revolution (Axisymmetric)

Chapter 5 – Vibration by Finite Elements (2 weeks)

1. Introduction
2. A reminder about vibrations (Free vibration, Forced vibration; System with multiple degrees of freedom…)
3. Bar element (Consistent formulation, Inconsistent formulation)
4. Element flexion
5. Vibration of structures Winches
6. Combined vibration (axial-flexural) of the bar element (Axial vibration, Flexural vibration)

Chapter 6 - Additional Formulations (3 weeks)

- Finite element techniques
  - Mesh design
  - Distortion
  - How to choose a mesh
  - Convergence
- material non-linearity
  - Elastoplasticity
  - Elastoplastic behavior
  - Problem-solving techniques
- Thermal problems

Practical Exercise: Finite Element Method

Programming and use of calculation codes (working with the finite element method – Example Comsol multiphysics)

Numerical simulation of some examples in the field

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *JF Imbert, "Analysis of Structures by Finite Elements", Cepadues, 3rd Ed., 1991.*
2. *Jean-Louis Batoz, Gouri Dhatt, "Modeling of Structures by Finite Elements, Volume 1: Elastic Solids", Hermès Sciences Publication 1990.*
3. *Jean-Louis Batoz, Gouri Dhatt, "Modeling of Structures by Finite Elements, Volume 2: Beams & Plates", Hermès Sciences Publication 1990.*
4. *Jean-Louis Batoz, "Modeling of Structures by Finite Elements, Volume 3: Shells", Hermès Sciences Publication 1992.*
5. *OCZienkiewicz, "The Finite Element Method", Mc Graw Hill, 1979.*
6. *Understanding finite elements (Principles, formulation and solved exercises)*
7. *Rahmani O and Kebdani S., Introduction to the finite element method for engineers, 2nd ed. OPU, 1994.*
8. *D. Ouinas "Application of the finite element method for engineers, course and solved exercises". Volume 1-OPU 2012.*
9. *Paul Louis George, "Automatic Mesh Generation: Applications to Finite Element Methods", Dunod, 1990.*
10. *C. Zienkiewicz And RL Taylor, "The Finite Element Method For Solid And Structural Mechanics", Sixth Edition By O. Butterworth-Heinemann 2005.*

11. *AlaaChateauneuf, "Understanding Finite Elements: Structures. Principles, Formulations and Solved Exercises", Ellipses Marketing, July 2005.*

Semester: 7
Teaching Unit: UEF 7.1 IGMF 7.2
Subject: Elasticity
VHS: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

This course is an introduction to the fundamental concepts of elasticity, focusing on stress and strain tensors as well as Hooke's laws.

Recommended prior knowledge:

Strength of materials 1, matrix calculus, vector calculus

Contents of the material:

Chapter 1: Introduction, Mathematical Review (2weeks)
Vector calculus, tensor calculus.

Chapter 2: Stress Tensor (4 weeks)
Cut, facet and stress vector, Cauchy formula, stress tensor, Equilibrium equations, Principal stresses and principal directions, Scalar invariants of the stress tensor, Spherical tensor and deviator.

Chapter 3: Strain Tensors (4 weeks)
Displacement vector, Strain tensor, Transformation of lengths and angles, Principal deformations, Scalar invariants of the strain tensor, Spherical tensor and deviator.

Chapter 4: Hooke's Laws (Stress-Strain Relationships) (4 weeks)
Stress formulation, Strain formulation, Thermo-elastic formulation.

Chapter 5: Resistance Criteria (1 week)
Maximum normal stress criterion (Rankine criterion), Maximum shear criterion (Tresca criterion), Von Mises criterion.

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. Martin H. Sadd. “Elasticity: Theory, applications and Numerics”, Elsevier 2005.
2. Yves Debard. “Elasticity”, Lemans University, 2006.
3. Gabriel Lamé.Lessons on the mathematical theory of the elasticity of solid bodies»,Editions Jacques GabayParis 2006.
4. Denis Dartus.Linear elasticity»,Editions CepaduèsParis, 1995.
5. Jean Coirier.Mechanics of continuous media,Course and corrected exercises”, Dunod, 2013.

Semester: 7
Teaching unit: UEF 7.2 IGMF 7.3
Subject: Metal cutting 1
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 3
Coefficient: 2

Teaching objectives:

The program aims to provide students with a set of essential knowledge necessary for understanding the phenomenon of metal cutting during shaping. This ranges from chip removal to calculating cutting forces and the required power.

Recommended prior knowledge:

Basic concepts in mechanical manufacturing and machining.

Content of the material:

Chapter 1: Analysis of chip formation **(2 weeks)**
Chapter 2: Cutting tool geometry **(2 weeks)**
Chapter 3: Wear on cutting tools **(2 weeks)**
Chapter 4: Mechanical actions of the cutting process (cutting powers and forces) **(4 weeks)**
Chapter 5: Choice of cutting conditions **(5 Weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *L. Rimbaud, G. Layes, J. Moulin, Practical Guide to Machining, Hachette Technique, 2006.*
2. *J. SAINT-CHELY, "CHOICE OF TOOLS AND CUTTING CONDITIONS IN FILMING", 1993.*
3. *Pierre Bourdet. Metal Cutting. Course, École Normale Supérieure de Cachan, Ver 5 2004*
4. *J. Jacob, Y. Malesson, D. Ricque, Practical Guide to Machining 2: Turning, Hachette Techniques.*
5. *François BAGUR, Materials for cutting tools, Techniques de l'Ingénieur, Reference BM7080 v1, 1999.*
6. *Eric FELDER, Modeling of metal cutting, Techniques de l'Ingénieur, Reference BM7041 v1, 2006.*
7. *Eric FELDER, Machining Processes – Presentation, Engineering Techniques, Reference BM7000 v1, 2008.*
8. *Fikret KALAY, Numerical simulation of machining - Application to AU4G aluminum (A2024-T351), Techniques de l'Ingénieur, Reference BM7002 v1, 2010.*

Semester: 7
Teaching unit: UEF 7.2 IGMF 7.4
Subject: Shaping processes
VHS: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Material shaping techniques aim to give a **shape** determined to **material** while imposing a **geometry**, in order to obtain an object having the **properties** desired. Shaping techniques differ depending on the material. For metals, the main processes are: **Forging**, there **Foundry**, THE **Sintering**, L'**Stamping.**

Recommended prior knowledge:

Concepts of general mechanics

Content of the material:

Chapter 1: Main methods of material production	**(2 weeks)**
Chapter 2: Deformation forming processes	**(3 weeks)**
Chapter 3: The foundry	**(3 weeks)**
Chapter 4: Molding (molding of steels & plastics)	**(3 weeks)**
Chapter 5: Shaping of composite materials	**(2 weeks)**
Chapter 6: Powder processing: sintering	**(2 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *Claude CorbetMemotech - Material Forming Processes, Publisher(s):Casteilla, Collection :Memotech, 2005.*
2. *M. Ashby, Y. Bréchet, L. Salvo, SELECTION OF MATERIALS AND PROCESSES FOR IMPLEMENTATION, Vol. 20 of the Treatise on Materials, Presses polytechniques et universitaires romandes, 2001.*
3. *Eric FELDER, Metal forming - Mechanical and thermal aspects, Engineering Techniques, Reference M3000 v2, 2015.*
4. *Eric FELDER, Lubrication in forming - General principles and choices, Techniques de l'Ingénieur, Reference M3015 v1, 2006.*
5. *SUÉRY Michel, Forming of metallic alloys in the semi-solid state, Hermes, Lavoisier, 2002.*
6. *Battaglia Jean-LucHeat transfer in material forming processes: course and solved exercises,Paris Hermes science publ. 2007 Lavoisier.*

Semester: 7
Teaching unit: UEF 7.2 IGMF 7.5
Subject: Mechanical Manufacturing
VHS: 67h30(Course: 1h30, Tutorial: 1h30, Practical: 2h30)
Credits: 5
Coefficient: 3

Teaching objectives:

To become familiar with the different means of mechanical manufacturing, this subject aims to involve the student in manipulating the different machine tools of the mechanical manufacturing workshop, as well as work piece holders, tool holders, cutting tools and other accessories such as measuring and control instruments.

Recommended prior knowledge:

The student must assimilate the basic notions and concepts taught during the Mechanical manufacturing process courses.

Content of the material:

Plan some experiments related to mechanical manufacturing and metrology, depending on available resources. The proposed practical exercises in mechanical manufacturing focusing on machining are:

TP1 Kinematic study of machine tools (lathes and milling machines) **(2 weeks)**
TP2 Production of a model part on a machine tool **(4 weeks)**
TP3 Measuring angles and creating a cutting tool **(3 weeks)**
TP4 Determination of machining times using calculation methods and time studies **(2 weeks)**
TP5: Lab Project: Creation of a machining device **(4 weeks)**

Evaluation method:

Continuous monitoring: 100%

Bibliographical references:

1- *André Chevalier, Mechanical Manufacturing Technology, number 10, 1999.*
2- *René Pazot, Mechanical Manufacturing Technician's Handbook, Editions: Casteila, 2006.*
3- *Jean-Pierre Cordebois,Michel Colombié, Machining Manufacturing (Mechanics and Materials), Dunod, 2008.*
4- *Jean-Pierre Urso, Memo-form: Mechanical fabrications, Editions: El educalivre, 2002.*
5- *Jean-François MaurelMechanical Engineering - Design, Materials, Manufacturing, Control: Design, Materials, Manufacturing, Industrial Applications, Publisher: Dunod, 2015.*
6- *Claude BarlierMemotech Plus - Machining of metallic materials, Publisher(s):Casteilla, Collection :Memotech2010.*
7- *Souhir GaraMachining processes, turning - milling - drilling - grinding, Publisher(s):Ellipses, Collection :Technosup, 2014.*
8- *Louis Rimbaud,Gérard Layes,Joseph MoulinPractical Machining Guide - Volume 1, Publisher(s):Hatchet, Collection :Practical industrial guides, 2006.*
9- *Joseph Jacob,Y. Malesson,D. RicquePractical Machining Guide - Volume 2, Publisher(s):Hatchet, Collection :Practical guide, 2006.*
10- *Georges PaquetMachining Guide: Milling - Drilling - Boring - Broaching - Plastics Processing - Molding - Turning, Publisher(s):Delagrave, Collection :Industry guides, 2000.*

11- *R. Dietrich,D. Garsaud,S. Gentillon,Mr. Nicolas, Summary of machining methods, Publisher(s):AFNOR,Nathan, Collection :Accurate, 2003.*

Semester: 7
Teaching Unit: UET 7.1
Subject: Advanced Python Programming
VHS: 45h00 (Course 1h30, Practical 1h30)
Credits: 2
Coefficient: 2

Objectives of the subject:

Skills targeted:

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

Goals :

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

Materials needed:

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

Prerequisites: Python programming.

Content of the material:

Chapter 1: Reminderson programming in Python (2 weeks)

1. Introduction: Basic computer concepts and digital tools, installation of Python.
2. Introduction to the concept of an operating system: Roles, types (Linux, Windows, etc.), priority management,
3. Introduction to computer networks (Principles, IP address, DNS, internet, etc.)
4. Basic programming: Interactive mode and script mode, Variables, data types, operators. Conditional structures and loops (if, for, while).
5. Essential functions and elements: Predefined functions and function creation. Standard modules (math, random). Strings, lists, basic database manipulation.
6. Files, Lists, Tuples, Dictionaries,
7. Exercises:
    - Python learning exercises
    - Exercises using the libraries seen in the course (Math, Random, NumPy, Pandas,…)
    - …

Chapter 2: Programming and Automation (4 weeks)

1. Principles of Task Automation
    - Python libraries for automation:
        - ✓ Pandas and NumPy.
        - ✓ Os, shutil: file and folder manipulation
        - ✓ Openpyxl or pandas: working with Excel or CSV files
    - Definitions and examples of automation (sending emails, etc.)
2. File manipulation with Python:
    - Use the libraries to:

- ✓ Browse a folder (os.listdir)
- ✓ Check for the existence of a file or folder (os.path.exists)
- ✓ Create or delete folders (os.mkdir, os.rmdir)
- ✓ Visualizing data: Matplotlib, Seaborn, Plitly
- ✓ Request to interact with Application Programming Interfaces (APIs)
- ✓ Beautiful Soup for Data Scraping
- ✓ Tkinter, PyQt for visualizing graphical data

- Copying or moving files with shutil…
- Simple search, sorting and report generation.
- Serialization and Deserialization (Using the pickle module).
- Object serialization and processing of large files (streaming).
- …

3. **Exercises**:
   - Using openpyxl and pandas to read, modify, and write Excel or CSV files for:
     - ✓ Create automatic reports
     - ✓ Automatically extract data
     - ✓ …
   - Scriptwriting for:
     - ✓ processing text files (searching, sorting)
     - ✓ automate technical calculations
     - ✓ manage simple reports (PDF, Excel)
     - ✓ …
   - Sorting, search, and insertion sort algorithms
   - Implement a search function in a list.
   - File operation
   - Secure browsing (simple network setup, password management)
   - …

Chapter 3: Advanced Excel Learning **(2 weeks)**

1. Principles of macros and creating a simple macro,
2. Pivot tables,
3. Histograms,
4. Bar charts,
5. Spider,
6. Etc.
7. **Exercises** Excel…

Chapter 4: Learning Gantt Project **(2 weeks)**

1. Introduction to project management:
   - What is a project?
   - What are the challenges of managing a project?
   - Gantt Project Interface
2. THE tasks (creation, modification, organization)
3. Management time (project start or end dates)
4. Management resources
5. **Exercise** Gantt Project

Chapter 5: Advanced Object-Oriented Programming **(3 weeks)**

1. Code organization:
   - Custom functions, settings, return value.
2. Structures complex data:
   - Lists, tuple sand dictionaries: creation, modification, deletion, browsing.
3. Fundamental concepts of Programming object-oriented (OOP):

- Classes, objects, attributes, and methods.
- Public, private and protected attributes.

4. Special methods:
   - **init**, str, repr, len.
5. Advanced concepts:
   - Encapsulation, abstraction, inheritance, polymorphism.
   - Advanced heritage, decorators, design patterns, meta classes.
6. **Exercises**

Chapter 6:Introduction to Data for AI **(2 weeks)**

1. Introduction to common datasets in AI:
   - Iris, MNIST, CIFAR-10, Boston Housing, ImageNet.
2. Data preprocessing for Machine Learning:
   - Data cleaning, normalization, encoding, and separation.
   - Cross-validation.
3. Feature Engineering techniques:
   - Selection, feature creation, dimensioning.
4. Essential Libraries for the development of AI models:
   - scikit-learn, TensorFlow, Keras, PyTorch
5. **Exercises**

Practical exercises:

TP 01: Mastering the basics of Python programming

(Control structures, types, loops, simple functions)

1. Initiation
2. Read and process text files
3. Manage simple reports (PDF, Excel)

TP 02:

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

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

TP 03:

1. Excel programming of the dashboard seen in class
2. Creating automated Excel spreadsheets
3. Simple macros,
4. Conditional formulas,
5. Research V.

TP 04:

Organizing a meeting using Gantt project

1. Create a new project:
   - Project name: “Meeting…”
   - Start date: Date and time of the meeting
   - Estimated duration: total meeting time
2. Task definition
   - Agenda items (each agenda item becomes a task)
   - Subtasks: If a point is compound, then create the corresponding subtasks.
   - Initial and final tasks (e.g., "Welcoming participants", "closing the meeting")

3. Definition of resources:
    - Participants (each participant is a resource)
    - Equipment (computer, data projector…)
4. Estimated durations:
    - Duration of each item: time required for each item on the agenda
    - Transition time from one point to another
5. Creating the Gantt chart:
    - View the agenda
    - Identify the key points
6. Track progress in real time (Gantt chart projection)

TP 05: Advanced structures and code organization
(Custom functions, dictionaries, modules, and modular organization)

TP 06: Advanced Object-Oriented Programming in Python
(Encapsulation, inheritance, special methods, simple design patterns)

Lab 07: File Manipulation and Data Analysis
(Reading/writing files, word processing, introduction to Pandas and NumPy)

Lab 08: Data preparation and processing for artificial intelligence
(Loading AI datasets, cleaning, transformation, feature selection)

Final Project

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

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

Evaluation method:

Exam 60%, CC=40%

Bibliography

[1] . E.Schultz and M.Bussonnier (2020): Python for the Humanities and Social Sciences. Introduction to Data Programming. Presses Universitaires de Rennes.

[2] . C. Paroissin, (2021): Data science practice with R: arranging, visualizing, analyzing and presenting data. Paris: Ellipses, DL 2021.

[3] . S.Balech and C.Benavent: NLP text minig V4.0, (Paris Dauphine – 12/2019): link:https://www.researchgate.net/publication/337744581_NLP_text_mining_V40_-_une_introduction_-_cours_programme_doctoral

[4] . Allen B. Downey Think Python: How to Think Like a Computer Scientist, O'Reilly Media, 2015;

[5] . Ramalho, L.. Fluent Python. “O’Reilly Media, Inc.”, 2022;

[6] . Swinnen, G. Learning to program with Python 3. Editions Eyrolles, 2012;

[7] . Matthes, E. Python crash course: A hands-on, project-based introduction to programming. no starch press, 2019

[8] . Cyrille, H. (2018). Learning to Program with Python 3. Eyrolles, 6th edition. ISBN: 978-2212675214

[9] . Daniel, I. (2024). Learning to code in Python, I read

[10] . Nicolas, B. (2024). Python, from complete beginner to object-oriented programming: Course and solved exercises, 3rd edition, Ellipses

[11] . Ludivine, C. (2024). Selenium: Master your functional tests with Python, Eni

Online resources:

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

Semester 7
Teaching unit: UEM 7.1 IGMF 7.6
Subject: Personal Professional Project
VHS: Over-quota hourly volume
Credits: 2
Coefficient: 2

Some examples of topics:

- System reliability
- Industrial maintenance and safety.
- Business creation and procedures
- Introduction to Artificial Intelligence
- Introduction to innovation
- Non-destructive testing
- Repairs and Interventions
- Eco-Manufacturing
- Sensors and measurement techniques
- Tribology and lubrication of mechanical systems
- Quality Management
- Industrial risks and safety techniques
- Human factors
- 3D printing

Semester: 7
Teaching unit: UEF 7.2 IGMF 7.6
Subject 3: Defect Detection Techniques
VHS: 45 hours(Course: 1h30, Practical: 1h30)
Credits: 2
Coefficient: 2

Teaching objectives:

In this module, the student will learn about the different types of diagnosis and how to classify them. failures and choosing the best detection tool(s)

Recommended prior knowledge:

Basic concepts of mechanical engineering

Contents of the material:

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

Chapter 2: Vibration Analysis, Areas of application, Principle of vibration analysis, Main defects. **(3 weeks)**

Chapter 3: Infrared thermography analysis, Areas of application, Principle of thermo graphic analysis, Temperature and heat, Infrared radiation, Measurement methods, Structure of an imager, Methodology, Approach, Creation of a signature. **(3 weeks)**

Chapter 4: Non-destructive testing, NDT methods, Dye penetrant testing, Magnetic particle testing, Radiography, Eddy currents, Areas of application. **(2 weeks)**

Chapter 5: Ultrasonic acoustic analysis, Theory of sound and ultrasound, Introduction to ultrasound detection, Ultrasonic inspection integrated into a condition-based maintenance program. **(3 weeks)**

Chapter 6: Oil analysis, Types of oil analysis, Main methods of oil analysis, By Centrifugation, By Filtration, By Ferrography, By Spectrometry, By Flash Point Measurement, By Water Titration, By Counting. **(3 weeks)**

Practical work: Fault detection techniques

Teaching objectives:

This practical exercise will allow the student to apply the different types of diagnostics, and will be able to choose the best detection tool(s) depending on the system failure.

Recommended prior knowledge:

Maintenance, vibration and structural dynamics, rotating machinery.

Contents of the material:

TP 1: Failure Analysis using the ABC method
TP 2: Study of electric motor failures
TP 3: detection of faults in automated systems
TP 4: failure in electronic systems

TP 5: FMEA Method and Functional Analysis

Evaluation method:
Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *Gilles Zwingelstein, Failure Diagnosis, Hermes Science Publications, 2002.*
2. *Philippe ArquèsPredictive diagnosis and machine failures: Theory, processing, analysis, recognition, prediction, TECHNIP, 2009.*
3. *G. Zwingelstein, "Failure Diagnosis: Theory and Practice for Industrial Systems", Treatise on New Technologies, Hermès Edition 1995.*
4. *Flandrin, "Time-frequency analysis", Editions Hermes, 1994.*
5. *Chiollaz M, Favre B, "Fine characterization of motor noise by time-frequency analysis", Signal Processing Review, vol 8(5), 1990.*

Semester: 7
Teaching Unit: UEM 7.1 IGMF 7.8
Subject: Measurement techniques
VHS: 22h30(Course: 1h30, Practical: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

The student will learn the principles of Instrumentation and Regulation (Metrology, Process Control, Physical Quantities, Passive, Active, Integrated Sensors, Characteristics, Transmitter and Standards and Functional Diagram).

Recommended prior knowledge:
General mechanics, electricity, Basic elements of electronics.

Content of the material:
Chapter 1: Introduction **(1 week)**
Chapter 2 Different types of measurements **(4 weeks)**
2.1 Measurement of acoustic and vibrational quantities
2.2 Measurement of electrical quantities
2.3 Measurement of hydraulic and pneumatic quantities 2.4 Measurement of thermal quantities
Chapter 3: Measurement techniques in fluid mechanics **(4 weeks)**
- Traditional techniques (Pitot, Wire and Hot Film)
- Optical techniques (LDA, PIV, Stereoscopic PIV)
Chapter 4 Organization, methods and measurement techniques **(2 weeks)**
Chapter 7 Data Processing **(2 weeks)**
Chapter 8: Introduction to experimental designs **(2 weeks)**

Evaluation method:
Exam: 100%.

Bibliographical references:
1. *"Physical measurements and instrumentation: Statistical and spectral analysis of measurements, sensors", Barchiesi, Dominique, Paris, Ellipse, 2003.*
2. *"Sensors in industrial instrumentation", Asch, Georges, Paris, Dunod, 1999.*

RJ Goldstein, "Fluid Mechanics Measurements", 1983.

Semester: 7
Teaching Unit: UED 7.1 IGMF 7.9
Subject: Industrial Robotics
VHS: 45 hours (3-hour course)
Credits: 1
Coefficient: 1

Teaching objectives:

Acquisition of mechanical description and modeling tools for robotics, considering open chain systems and kinematic cycle systems.

Recommended prior knowledge:

Mechanism theory, DAO, **Rational mechanics,** Mechanical engineering and general technology.

Content of the material:

Chapter 1: Introduction to Robotics **(2 weeks)**
(Definitions - Structure - Robot Kinematics, Robots)
Serial robots, parallel robots, mobile robots. Etc.)

Chapter 2: Parameterization of a solid and a chain of solids in space **(2 weeks)**

Chapter 3: Direct and inverse geometric models **(3 weeks)**

Chapter 4: Direct and inverse kinematic models **(2 weeks)**

Chapter 5: Dynamic modeling (Lagrange formalism,
Formalism of Newton-Euler) **(3 weeks)**

Chapter 6: Generation of movement **(2 weeks)**

Chapter 7: Geometric calibration **(2 weeks)**

Chapter 8: Geometric Modeling of Parallel Robots
Case study: DELTA robot used in FM **(1 week)**

- **Mini-project:** Choosing a robot for a task in Mechanical Manufacturing & production and optimal placement of a robot in-situ.

Or one:

- **Practical exercise: Programming a robot (point-based tasks, continuous tasks, pick and place)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *Philippe Coiffet.Robotics: Principles and ApplicationsHermes Science, 1992.*
2. *Max Giordano and Jacques Lottin. Robotics Course: Description and Operation of Industrial Robots. Armand Colin, 1997.*
3. *Wisama Khalil and Etienne Dombre. Modeling, identification and control of robots. Hermes Science, 1999.*
4. *JP Lallemand and S. Zeghloul. Robotics: Fundamental Aspects. Masson, 1994.*
5. *Alain Liégeois. Modeling and control of manipulator robots. Techniques de l'ingénieur, S7730: 2000.*

Semester 7
Teaching unit: UET 7.1 IGMF 7.10
Subject 1: HSI in Mechanical Manufacturing
VHS: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

Introduction to the main aspects of risk management and an introduction to occupational health and environmental protection.

Recommended prior knowledge:

None

Content of the material

Introduction to risk assessment and management, Accident analysis (3 weeks)

- Understand the basic concepts (danger, risk) and identify the actors in prevention.
- Mastering the indicators relating to workplace accidents (frequency rate, severity rate, etc.) and occupational diseases.
- Observe and analyze the risks associated with a work situation.
- Develop a cause-and-effect diagram.
- To become familiar with the purpose of the single document.

Chapter 2: Introduction to occupational health and environmental protection. (3 weeks)

- Identify the main aspects related to hygiene and public health.
- Understanding basic hygiene principles in the workplace environment.
- To know the main areas of environmental protection.
- To understand the issue of sustainable development.
- Identify the role and mission of the various health-related organizations.
- Workplace safety and public health.

Chapter 3: HSE specific to the field of mechanical manufacturing (3 weeks)

Chapter 4: Algerian legislation on HSE (2 weeks)

Chapter 5: First Aid (3 weeks)

To know and practice first aid techniques and actions.

Evaluation method:

Continuous Monitoring: 100%.

Bibliographical references:

- Gilles Zwingelstein, IndustrialDiagnosis, Hermès 2003
- Gilles Zwingelstein, Maintenance based on reliability, Hermès 1997
- MAGNE Laurent, VASSEUR Dominique, Industrial Risks: Complexity, Uncertainty and Decision-Making: An Interdisciplinary Approach; Series Editor: EDF R&D, Lavoisier 2006

Detailed program by subject for semester 8

Semester: 8
Fundamental Unit: UEF 8.1 IGMF 8.1
Subject: Machine tool components
VHS: 90h00 (Course: 1h30, tutorial: 3h00, practical: 1h30)
Credits: 7
Coefficient: 4

Teaching objectives:

Learn new numerical techniques to solve the various equations arising in energy (fluid mechanics, heat transfer, etc.). Emphasis will be placed on solving differential and partial differential equations.

Recommended prior knowledge:

The Fluid Mechanics MDF2 course (L3), mathematics, numerical methods (Bachelor's degree)

Content of the material:

Chapter 1:**First-order equations**, **(3 weeks)**

Taylor series expansion, Euler's method and error propagation, Runge-Kutta methods and error estimation, ODE systems, multistep methods, prediction-correction method. Application to boundary layer equations for forced and natural flow and convection on flat plates.

Chapter 2:**Finite difference methods**: **(3 weeks)**

Presentation of the method. Solving a stationary 2D conduction problem representing an elliptic equation. Direct and iterative solutions of the resulting system. Multistepping methods and Douglas-Rachford stationarization techniques, convergence optimization

Chapter 3:**Parabolic equations**: **(2 weeks)**

Case of unsteady conduction (or mass diffusion) 1D: Pure explicit schemes, pure implicit schemes, and Crank-Nicholson schemes. Case 2D: Two-time-level methods, ADE, Peaceman-Racheford ADI

Chapter 4:**Hyperbolic equations**: **(2 weeks)**

Method of characteristics. Burgers' equation, sound waves in a fluid

Chapter 5: Study of the errors resulting from these types of schemes: **(2 weeks)**

Consistency, stability, convergence, dissipation and dispersion

Chapter 6:**Finite volume method**: **(3 weeks)**

Advantages and disadvantages compared to finite differences. Application to the MDF (SIMPLE, SIMPLER, SIMPLEQ, QUICK, and TEAMKE algorithms for turbulent systems). How to choose?

Practical Exercise: Elements of Machine Tools

The goal is to teach the student the design of all the elements of a machine tool (conventional or CNC) and then its assembly using CAD tools, and then to perform a simulation of the kinematics of the movement of a structure and also of a machining cycle.

Recommended prior knowledge:

Basic knowledge of industrial drawing, CAD and CAM.

Contents of the material:

TP1: Manipulation of 3D CAD software **(3 weeks)**

Proficiency in using 3D CAD software (SOLIDWORKS, CATIA, INVENTOR,…)
2D creation tools: lines, arcs of circles.
Manipulation of 3D creation tools
Moving, copying, rotating along various axes,

TP2: Using objects from the CAD library **(2 weeks)**

Library objects: drilling, threading, assembly element, …

TP3: Assembly of machine tool components **(2 weeks)**

Assembly
floor plan

TP4: Examples of machine tool component designs **(3 weeks)**

Design of a swivel table
Design of a cradle-style table
Design of a chuck

TP 5: Design of a milling cutter holder **(3 weeks)**

Design of a milling cutter holder (cone jaw and HSK)

TP 6: Simulation of the Kinematics of the motion of a structure **(2 weeks)**

Kinematics of the motion of a machine tool structure

Evaluation method:

Continuous assessment: 100%

Bibliographical references:

Evaluation method:

Continuous Assessment: 40%, Examination: 60%.

Bibliographical references:

1. *Heinrich GerlingMachine Tools, Edition(s): Eyrolles.*
2. *François Pruvot, Design and calculation of machine tools, volume 1, Generalities, Morphology, General Plan, Presses Polytechniques Universitaires Romandes, 1993.*
3. *François Pruvot, Design and calculation of machine tools, volume 2, Spindles: Kinematic and static study, Presses Polytechniques Universitaires Romandes, 1993.*
4. *François Pruvot, Design and calculation of machine tools, volume 3, Spindles: Dynamic study, Presses Polytechniques Universitaires Romandes, 1999.*
5. *Georges Spinnler, Machine Design: Principles and Applications. 1- Statics, Presses Polytechniques Universitaires Romandes, 2002.*
6. *François C. PRUVOT, Machine tool - Main components, Techniques de l'Ingénieur, Reference B7121 v1, 1997.*
7. *Georges Spinnler, Machine design: principles and applications. 2- Dynamics, Presses Polytechniques Universitaires Romandes, 1997.*

Georges Spinnler, Machine design: principles and applications. 3- Dimensioning, Presses Polytechniques Universitaires Romandes, 1998.

Semester: 8
Fundamental Unit: UEF 8.1 IGMF 8.2
Subject: Metal cutting 2
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 3
Coefficient: 2

Teaching objectives:

The objective of the subject "**2" Metal Cutting** is to deepen the knowledge provided in the subject matter"**1" Metal Cutting** This allows us to find other knowledge with more details. These two subjects aim to achieve a good understanding and mastery of the cutting phenomenon.

Recommended prior knowledge:

Basic concepts in mechanical manufacturing and machining.

Contents of the material:

Chapter I:: Economic aspects and optimization of machining operations **(2 weeks)**

- cutting parameter optimization criteria
- machining time
- machining cost
- research into the optimum cost in machining

Chapter II: Nature and properties of cutting tools **(3 weeks)**
- Introduction
- Different types of cutting tools
- Metallurgical properties of cutting tools

Chapter III: Hard machining and dry machining – the machinability of materials **(3 weeks)**
Chapter IV: Analytical modeling of the cross-section **(3 weeks)**
Chapter V: Digital modeling of the cross-section **(2 weeks)**
(thermomechanical modeling)
Chapter VI: Machining of plastics and materials **(2 weeks)**
composite materials

Evaluation method:

Continuous assessment: 40%; Examination: 60%

Bibliographical references:

1- Claude BARLIERIndustrialization & Mechanics - Machining of metallic materials, Publisher:CASTEILLA, Collection: Mémotechplus, 2006.
2- Aouici,Hamdi,Yallese,Mohamed Athmane, Coupe des metaux, Edition(s): KartonierterEinband (Kt), 2014.
3- Claude BarlierMemotech Plus - Machining of metallic materials, Publisher(s):Casteilla, Collection :Memotech, 2010.
4- Souhir GaraMachining processes, turning, milling, drilling, grinding, Publisher(s):Ellipses, Collection :Technosup, 2014.
5- James A. Harvey,Michel GauthierMachining - The secrets of the trade, Publisher(s):Reynald Goulet,Tec et Doc - Lavoisier,Hermès - Lavoisier, 2006.

Semester: 8
Fundamental Unit: UEF 8.2 IGMF 8.3
Subject: Welding Techniques
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practical: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives

This subject aims to familiarize students with the different types of welding and to provide them with the principles of prevention during welding operations.

Recommended prior knowledge

Materials Science

Content of the material

Chapter 1: Introduction **(2 weeks)**
1.1 History of Welding 1.2 Terminology

Chapter 2: Gas welding **(2 weeks)**

2.1 Introduction 2.2 Equipment 2.3 Gas Flames 2.4 Welding Techniques 2.5 Applications

Chapter 3: Arc welding **(3 weeks)**
3.1 Introduction 3.2 Elements of Physics 3.3 Molten Metal Transfer 3.4 Arc Blowing 3.5 Shielding Gas
3.6 Standardization of shielding gases 3.7 Standards applicable to electrodes and filler metals

Chapter 4: Arc welding power supply **(2 weeks)**
4.1 Introduction 63 4.2 Electrical Characteristics and Control 63 4.3 Different Types of Welding Power Supplies 67 4.4 Control of Power Supplies 71 4.5 Characteristics of Power Supplies 74 4.6 Safety Requirements

Chapter 5: TIG Welding **(1 week)**
5.1 Introduction 5.2 Equipment 5.3 Consumables 5.4 Quality Issues

Chapter 6: Plasma welding **(1 week)**
6.1 Introduction
6.2 Classification of plasma welding processes
6.3 Equipment
6.4 Gases used for plasma welding

Chapter 7: MIG/MAG Welding **(1 week)**
7.1 Introduction 7.2 Equipment 7.3 Consumables 7.4 Variations of the MIG/MAG process 7.5 MIG/MAG welding quality

Chapter 8: Other welding processes **(1 week)**
8.1 Arc welding with coated electrodes
8.2 Submerged Arc Welding
8.3 Pressure welding processes

Chapter 9: Welding hygiene and safety **(2 weeks)**
9.1 Introduction
9.2 Welding fumes and gases 9.3 Electrical hazards

Practical Exercises:

Practical Exercise 1: Semi-automatic flat welding of metal structures
Practical Exercise 2: Flat welding of metal structures using TIG
Practical Exercise 3: Flat welding of metal structures using coated electrodes
TP 4: Semi-automatic welding of metal structures in position
Practical Exercise 5: Spot Welding

Evaluation method:
Continuous assessment: 40%; Examination: 60%

Bibliographical references
1. K. Weman and D. Gouadec, "Aide-mémoire des processus de soudure" [Welding Process Handbook], Dunod, 2005
2. C. Paquet, L. Lévesque, M. Bramat, W. Bowditch, K. Bowditch, M. Bowditch, A. Althouse and C. Turnquist, "Arc welding processes", De Boeck, Reynald Goulet, 2007.

Semester: 8
Fundamental Unit: UEF 8.2 IGMF 8.4
Subject: Surface corrosion and protection
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practical: 1h30)
Credits: 5
Coefficient: 3

Recommended prior knowledge:
This course is designed and structured to provide students with essential knowledge about corrosion and metal protection in a clear and accessible way. It covers the phenomenon of corrosion (definition, types, causes, etc.) as well as the thermodynamic conditions that promote its development and the parameters that govern its kinetics.

Recommended prior knowledge
Materials Science

Content of the material:

CHAPTER 1: Introduction to Metal Corrosion **(3 weeks)**

CHAPTER 2: Thermodynamics of electrochemical corrosion **(3 weeks)**

CHAPTER 3: Kinetics of electrochemical corrosion **(3 weeks)**

CHAPTER 4: Corrosion Protection Methods **(4 weeks)**

CHAPTER 5: Dry corrosion **(2 weeks)**

Evaluation method:
Exam: 100%.

Bibliographical references
.1 Dieter LANDOLT, Corrosion and surface chemistry of materials, Presses polytechniques et universitaires Romandes, first edition (1993).
2. François COEURET, Alain STORCK, Element of Electrochemical Engineering, Technique & Documentation-LAVOISIER, (1993).
3. Christian VARGEL, Corrosion of Aluminum, Edition Dunod.
4. François ROPITAL, Corrosion and Degradation of Metallic Materials, Yves CHAUVIN, Technip Edition, (2009).
5. André RAHArinaivo, Corrosion and Protection of Steel in Concrete, Presses de l'Ecole Nationale des Ponts et Chaussées.
6. Paul ARNAUD, Physical Chemistry, Course and Applications, 5th Edition, Dunod, Paris, (2001).
7. Fabien MIOMANDRE, Electrochemistry, From Concepts to Applications, Dunod Edition, Paris, (2005).
8. John Christopher Scully, Corrosion Protection, Fundamental Principles, Masson, Paris, Milan, Barcelona, (1995).
9. Jean.P MERCIER, Gérald ZAMBELLI, Wilfried KURZ, Treatise on Materials, Introduction to the Science of Materials, 3rd Edition, Presses Polytechniques et Universitaires Romandes, (2002).
10. Christine LEFROU, Pierre FABRY, Jean-Claude POIGNET, Electrochemistry, Fundamentals to Corrected Exercises, EDP Science, France, (2009).

11. Jean BESSON, Précis de Thermodynamique & Kinétique Electrochimiques, Ellipses, Edition (1984).
12. Peter William ATKINS, Elements of Physical Chemistry, DeBook University, Paris, Brussels, (1998).
13. https://fr.wikipedia.org/wiki/Corrosion
14. http://www.corrosion-doctors.org/

Semester: 8
Fundamental Unit: UEF 8.2 IGMF 8.5
Subject: Hydraulic and pneumatic systems and devices
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The program's objective is to provide students with a set of essential knowledge necessary for a physical understanding of hydraulic and pneumatic systems. This begins with the description of the various components (cylinders, distributors, valves, etc.) and progresses to the creation of hydraulic or pneumatic diagrams.

Recommended prior knowledge:

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

Content of the material:

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

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

Chapter 2: Hydraulic pumps, compressors and motors **(6 weeks)**

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

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

- Distributors: Types, construction, selection and ordering (direct, indirect).
- Pressure limiters: Types, construction, selection and control (direct, indirect).
- Flow restrictors: Types, construction, selection and control (direct, indirect).
- Accumulators and reservoirs: Types, calculation and selection.
- Pipes: Materials, dimensions.
- Sensors: force, speed, position, temperature, etc.

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

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

Evaluation method:

Continuous monitoring: 100%

Bibliographical references:

1. *Jacques Faisandier, Hydraulic and Pneumatic Mechanisms, Collection:Technology and Engineering, Dunod/L'Usine Nouvelle, 2013.*
2. *José RoldanViloria, Aide-mémoire: Industrial Hydraulics, L'Usine Nouvelle - Dunod.*
3. *R.-C. Weber, Safety of pneumatic systems, Festo Edition, 2012.*
4. *Simon Moreno,Edmond PeulotPneumatics in automated production systems, Publisher(s):Casteilla, 2001.*

Semester: 8
Teaching Unit: UED 8.1 IGME 8.6
Subject: Mechanical Properties of Materials
VHS: 45 hours (Course: 1h30, Practical: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

At the end of the course, the student will be expected to know the crystal structure, microstructure, as well as the mechanical properties of the main ferrous and non-ferrous materials and their designation.

Recommended prior knowledge

Concepts in Materials Science

Content of the material:

Chapter 1 General information on stress and deformation **(1 week)**

Chapter 2 Mechanical behavior **(2 weeks)**

Chapter 3 Elastic properties: spring models, electrostatic models, fragile materials **(3 weeks)**

Chapter 4 Plastic properties **(2 weeks)**

Chapter 5 main types of defects (point, linear, surface, Volumetric **(3 weeks)**

Chapter 6 role of dislocations in plastic deformation **(2 weeks)**

Chapter 7 Modifying properties **(2 weeks)**

<u>Practical exercises:</u> Depending on the resources and availability of the establishment

Evaluation method: Continuous assessment 40% and Examination 60%

Bibliographical references:

1- Treatise on Materials, Introduction to Materials Science, JPMercier, G.Zambelli, W.Kurz, Presses polytechniques et universitaire romande

2- Materials, Jean-Paul Baïlon, Jean-Marie Dorlot,International Polytechnic Press

3- Materials Science and Engineering, WDCallister, Jr., MODULO

Semester: 8
Teaching Unit: UET 8.1 IGME 8.7
Subject: Company Internship 2
VHS: 22h30(Course: 1h30)
Credit: 1
Coefficient: 1

Semester: 8
Teaching Unit: UEM 8.1 GMF 8.8
Subject: Methods Office
VHS: 10:30 p.m. (tutorials: 1h30, 1h30. tutorials)
Credits: 1
Coefficient: 1

Teaching objectives:

The methods office constitutes the interface between the manufacturing or production workshops and the design offices. Indeed, the roles and missions of the methods department, in particular, allows for verification, in conjunction with the design office, of the feasibility and manufacturability of a product. The teaching provided aims primarily to introduce students to developing a manufacturing process, taking into account the product definition drawing, the type of production, and the resources and tools essential for its realization. The ultimate goal is for the learner to acquire the knowledge required to establish a complete product manufacturing process, particularly the design of machining sequence plans and the development of phase contracts. It is essential that these plans integrate, in accordance with production costs, the scheduling of the various machining operations and their grouping into sub-phases and phases, the judicious selection of machine tools and tooling, and the calculation of machining times.

Recommended prior knowledge:

Industrial drawing, Basic technology, Mechanical manufacturing, Materials science, Practical work in mechanical manufacturing, Conventional and Advanced Manufacturing Techniques.

Content of the material:

Course program **(1.5 hours/week)**

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

I-1 The production function.
I-1 Role and mission of a methods office.
I-2 Analysis of the definition drawing.
I-3 Concepts of form and position tolerances.
I-1 Role and mission of a methods office.

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

II-1 Taking part.
II-2 Geometric symbolization.
II-3 Choice of positioning surfaces.
II-4 Technological symbolization.
II-5 Application examples.

Chapter 3: Manufacturing Quotation **(3 weeks)**

III-1 Manufacturing dimensions: tool dimensions, machine dimensions and equipment dimensions

III-2 Transfer of dimension and orientation.

III-2 Examples of rating transfer.

Chapter 4: Elementary operations and precedence **due to constraints** *machining*

(2 weeks)

IV -1 The basic machining operations: turning, milling, drilling, boring, gear cutting and grinding.

IV-2 Prior History due to machining constraints: dimensional, geometric and technological.

Chapter 4: Establishing a complete product manufacturing process and designing machining sequences (5 weeks)

V-1 Determination of the number of machining operations according to the quality and condition of the machined surface.

V-2 Determination of the precedence of machining operations.

V-3 Matrix method for establishing the machining order.

V-4 Grouping of machining operations in phase and sub-phase.

V-5 Machining range project.

V-6 Contract of the different machining phases and choice of cutting regime.

V-7 Drawing and production of the raw part.

V-8 Examples of machining range.

Evaluation method:

Continuous assessment: 40%, Examination: 60%

Bibliographical references:

[1]AnselmettiB., '*Tolerance Manual(Volume 4): Manufacturing dimensioning with ISO standards*',Hermes Science Publications, 2010.

[2]GaraS., '*Production engineering - Machining processes:Turning, milling, drilling, grinding*', EditionsEllipses Marketing2014

[3] Pimbaud L., Layes G., Moulin J., 'Practical guide to machining (volume 1)', Hachette Edition, 2003.

[4] Barlier C., Poulet B., 'Mechanical Production', Mémotech Collection, Casteilla Editions, 1999

[5] Chevalier A, Bohan J., Molina A., 'Practical guide to production engineering', Editions Hachette, 2000.

[6] Padilla P. and Thely A., 'Guide des Fabrications Mécaniques', Dunod, 1978.

[7] Padilla P.,AnselmettiB., Mathieu L. and Raboyeau M., 'Mechanical Production', Editions Dunod, 1986.

[8] Weill R., 'Design of machining ranges', Techniques de l'ingénieur Doc B2 025, 1993

[9] Matthieu L. and Weill R., 'A Model for Machine Tool Setting as a Function of Positioning Errors' CIRP International WorkingSeminar on Computer-Aided Tolerancing, The Pennsylvania State University, 1991.

[10] Hassin S., 'Multi-criteria qualification of machining ranges: application to aeronautical structural parts in Airware alloy', Doctoral thesis, Blaise Pascal University - Clermont-Ferrand II, 2015.

Semester: 8
Teaching Unit: UET 8.1 IGME 8.8
Subject: Respect for standards and rules of ethics and integrity.
VHS: 22h30(Course: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

To raise students' awareness of ethical principles and the rules governing life at university and in the workplace. To educate them about respecting and valuing intellectual property. To explain the risks of moral failings such as corruption and how to combat them, and to alert them to the ethical issues raised by new technologies and sustainable development.

Recommended prior knowledge:

Ethics and professional conduct (the foundations)

Content of the material:

A.Respect for the rules of ethics and integrity,

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

2. Ethical and responsible research

- Respect for ethical principles in teaching and research
- Responsibilities in teamwork: Equal professional treatment. Conduct against discrimination. Pursuit of the common good. Inappropriate conduct in the context of teamwork
- Adopting responsible conduct and combating abuses: Adopting responsible conduct in research. Scientific fraud. Conduct against fraud. Plagiarism (definition of plagiarism, different forms of plagiarism, procedures to avoid unintentional plagiarism, detection of plagiarism, sanctions against plagiarists, etc.). Falsification and fabrication of data.

3. Ethics and professional conduct in the workplace:

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

B- Intellectual Property

I- Fundamentals of Intellectual Property

1- Industrial property. Literary and artistic property.
2- Rules for citing references (books, scientific articles, communications) in a conference, theses, dissertations, …)

II- Copyright

1. **Copyright in the digital environment**

Introduction. Copyright databases, software copyright Specific case of free software.

2. **Copyright in the internet and e-commerce**

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

3. Patent

Definition. Rights in a patent. Usefulness of a patent. The Patentability. Patent application in Algeria and around the world.

III- Protection and enhancement of intellectual property

How to protect intellectual property. Rights infringement and legal tools. V Intellectual property valorization. Intellectual property protection in Algeria.

C. Ethics, sustainable development and new technologies

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

Teaching objectives:

To raise students' awareness of ethical principles and the rules governing life at university and in the workplace. To educate them about respecting and valuing intellectual property. To explain the risks of moral failings such as corruption and how to combat them, and to alert them to the ethical issues raised by new technologies and sustainable development.

Recommended prior knowledge:

Ethics and professional conduct (the foundations)

Content of the material:

B. Respect for the rules of ethics and integrity,

2. **Reminder of the MESRS Charter of Ethics and Professional Conduct:** Integrity and honesty. Academic freedom. Mutual respect. Demand for scientific truth, objectivity and critical thinking. Fairness. Rights and obligations of the student, of the teacher, administrative and technical staff,

2. Ethical and responsible research

- Respect for ethical principles in teaching and research
- Responsibilities in teamwork: Equal professional treatment. Conduct against discrimination. Pursuit of the common good. Inappropriate conduct in the context of teamwork
- Adopting responsible conduct and combating abuses: Adopting responsible conduct in research. Scientific fraud. Conduct against fraud. Plagiarism (definition of plagiarism, different forms of plagiarism, procedures to avoid unintentional plagiarism, detection of plagiarism, sanctions against plagiarists, etc.). Falsification and fabrication of data.

4. Ethics and professional conduct in the workplace:

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

B- Intellectual Property

I- Fundamentals of Intellectual Property

3- Industrial property. Literary and artistic property.

4- Rules for citing references (books, scientific articles, communications) in a conference, theses, dissertations, …)

II- Copyright

4. Copyright in the digital environment

Introduction. Copyright databases, software copyright. Specific case of free software.

5. Copyright in the internet and e-commerce

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

6. Patent

Definition. Rights in a patent. Usefulness of a patent. The Patentability. Patent application in Algeria and around the world.

III- Protection and enhancement of intellectual property

How to protect intellectual property. Rights infringement and legal tools. VI ntellectual property valorization. Intellectual property protection in Algeria.

C. Ethics, sustainable development and new technologies

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

Semester: 8
Teaching Unit: 8.1
Subject: Elements of applied artificial intelligence
VHS: 45h00 (Course 1h30, Practical 1h30)
Credits: 2
Coefficient: 2

Skills targeted:

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

Goals :

- Mastery of AI algorithms
- An introduction to the fundamental concepts, tools, and applications of modern artificial intelligence, with an emphasis on hands-on practice with Python and its libraries.
- To deepen one's knowledge of the Python language,
- Understanding AI approaches to problem-solving,

Prerequisites:

Advanced Python Programming

Materials needed:

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

Content of the material:

Chapter 1:Introduction to Artificial Intelligence (AI) (1 week)

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

Chapter 2:Basic Mathematics for AI (1 week)

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

Chapter 3: Machine Learning (3 weeks)

1. Key concepts: Data, Models, features, labels, generalization.
2. Phases of a learning pipeline: training, validation, testing.

3. Types of learning:
    - Supervised
    - **No** supervised
    - **By** reinforcement (overview)
4. **Exercises:**
    - To delve deeper into the concepts covered in the course
    - …

Chapter 4: Supervised Classification (3 weeks)

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

Chapter 5:Unsupervised learning

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

Chapter 6:Neural networks

1. Neural network architecture:
    - Perception,
    - Layers and hidden layers, weight, bias.
    - Function activation:, Sigmoid, Softmax, ….
    - Application exercises
2. Introduction to Deep Learning:
    - Concept of deep layers.
    - Introduction to Convolutional Neural Networks (CNNs)
3. **Exercises:**
    - Explaining Tensor Flow and Py Torch
    - Analyze a text dataset and predict sentiment
    - …

Chapter 7: Mini project (supervised personal work outside of class):

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

- Handwritten character recognition
- Natural disaster prediction
- Develop a chat bot capable of answering a company's frequently asked questions in a natural way.

- Develop a system capable of distinguishing normal machine sounds from those indicating an anomaly (defective bearing, excessive vibration, etc.)
- Develop a system (mini AI) capable of analyzing the sentiments expressed in social media posts about a product, brand or event.
- …

Practical exercises:

TP 01: Initialization

TP 02:

- Implementing a simple regression with Scik it-learn **visualization with Matplotlib** (For example)
- Visualize the results with Matplotlib
- …

TP 03:

- **Machine learning pipeline and data separation**
- To delve deeper into the concepts seen during the course

TP 04:

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

TP 05:

- Implementing a clustering algorithm on a dataset
- Visualize the clusters **Unsupervised clustering (K-means, DBSCAN).**
- …

TP 06:

- Build a simple neural network with Tensor Flow, Py Torch, or Keras
- Build a simple CNN to classify images (example: MINIST dataset)
- …

Evaluation method:

Exam 60%, CC=40%

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Bibliography:

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

Detailed program by subject for semester 9

Semester 9
Teaching Unit: UEF 9.1 IGMF 9.1
Subject 1: Advanced Structural Dynamics
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

This course aims to determine and solve the equation of motion for structures (free, constrained, damped, undamped, etc.). Understanding the different responses due to various loads informs us about the modes of vibration and the possibilities for their damping.

Recommended prior knowledge:

Knowledge is required in Solid Dynamics, Analytical Mechanics, Vibration and Waves and Strength of Materials.

Content of the material:

Chapter 1: Review of kinetics and dynamics (2 weeks)

Moment and inertia tensor of a material system and common geometries. Huygens-Koenigs theorem. Kinematic-kinetic-dynamic torsor - Kinetic energy. Fundamental Principle of Dynamics, Theorems of momentum, angular momentum, and kinetic energy. Principle of virtual work, Lagrange equations of the first and second kinds, Hamilton's principle.

Chapter II: Systems with One Degree of Freedom (2 weeks)

II.1 Undamped free oscillations
II.2 The stiffness coefficient of some systems
II.3 Damped Free Oscillations
II.4 Applications

Chapter III: Forced Oscillations of 1DOF Systems (2 weeks)

III.1 General Information
III.2 Forced oscillations due to harmonic loading
III.3 Forced oscillations due to a semi-sine impulsive loading
III.4 Forced Oscillations due to Spectral Loading - DUHAMEL Integral
III.5 Forced oscillations due to random loading

Chapter IV: Vibrations of continuous systems (3 weeks)

IV.1 Review of systems with multiple degrees of freedom.
IV.2 Vibrations of the strings.
IV.3 Beam vibrations.
IV.4 Membrane vibrations.

Chapter V: Variational methods for characterizing eigenvalues. (3 weeks)

V.1 The Rayleigh Quotient
V.2 Iterative search for modes and eigenvalues
V.3 Applications - Approximation of continuous systems (pendulums - beams in pure bending)

Chapter VI Numerical methods applied to structural dynamics

(3 weeks)

VI.1 The finite element method in beam dynamics
VI.2 Variational Formulation of Free Vibrations in Bending
VI.3 Calculation of free vibrations using finite elements

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *Vibration Theory, S. Timoshnko*
2. *Vibration Theory, Application to Structural Dynamics, M. Géradin*
3. *Structural DynamicsPatrick PaultreHermès - Lavoisier*
4. *Dynamics of Structures: Numerical Modal Analysis ofThomasGmürPublisher: Presses Polytechniques et Universitaires Romandes*
5. *Structural Dynamics, Volume 1, Principles and Fundamentals, RWCLOUGH and J. PENZIEN*
6. *Dynamics of structures: Numerical modal analysis,Thomas GmürPublisher: Presses Polytechniques et Universitaires Romandes*

Semester: 9
Teaching unit: UEF 9.1 IGMF 9.2
Subject: High-speed machining
VHS: 67h30 (Course: 1h30, Tutorials: 1h00, Practical: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:

High-speed machining has become, since the early 1990s, a crucial manufacturing process that must be implemented and understood to impress in the professional world. Beyond its marketing benefits, which have revitalized the mechanical manufacturing sector, high-speed machining offers significant advantages for producing high-quality mechanical parts, particularly in fields such as aerospace and mold making.

Recommended prior knowledge:

Basic concepts in machining and cutting conditions.

Contents of the material:

Chapter I: Theory and Principles of High-Speed Machining (HSM) **(4 Weeks)**
- High-speed machining equipment and cutting tools

Chapter II: Cutting regimes and surface finishes in high-speed machining **(4 Weeks)**
- Shooting strategies in UGV
- High-Speed Machining Strategies

Chapter III: Complex machining and multi-axis contouring (4-axis and 5-axis) **(4 Weeks)**
- Combined turning and milling of machining centers (C and Y axes)
- Cutting patterns (Analytical, Numerical, Thermo mechanical Approaches)

Chapter III: Other High-Speed Machining Models **(3 Weeks)**
- Plastics processing and high-speed machining of plastics and composite materials

TP

Practical exercises based on the course content and depending on the availability of materials

Evaluation method:

Continuous assessment: 40%; Examination: 60%

Bibliographical references:

1. *Phillipe Bagard UGV, complex shapes, large dimensions CETIM 1997*
2. *C. Bedrin High-speed cutting conditions: general principles and specific aspects 1996.*
3. *Technical Centre for Mechanical Industries. The advantages of high-speed machining CETIM 1996.*
4. *Alain-L. DEFRETIN, Gérard LEVAILLANT, High-speed machining, Techniques de l'Ingénieur, Reference BM7180 v1, 1999.*
5. *Christophe TournierHigh-speed machining - Technologies, modeling and trajectories, Collection:Technology and Engineering, Dunod/L'Usine Nouvelle, 2010.*
6. *Michael Kaufeld,*Serge Torbaty, Rationalisation De L'usinage Très Haute Vitesse, Publisher: Sofetec, Collection: Technologies D'aujourd'hui, 1999.
7. *Kindle, Mémotech - Methods and production in machining, Publisher: Casteilla, 2016.*

Semester: 9
Teaching unit: UEF 9.1 IGMF 9.3
Subject: Equipment installation
VHS: 45 hours (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Diagnose hazardous situations in installations or during machine use, define safety zones, understand the operation and use of machines.

Recommended prior knowledge:

Standards and regulations

Content of the material

Chapter 1. **(2 weeks)**

Background to the regulatory framework for the safety of industrial installations and equipment

Chapter 2. **(2 weeks)**

Terminology and definitions

Chapter 3. **(3 weeks)**

Ssafety of facilities

Chapter 4. **(4 weeks)**

Machine and equipment safety: Safety distances, guards, other safety devices (detectors, emergency stops, etc.)

Chapter 5. **(4 weeks)**

Machine operational safety: Control circuits, programmable logic controllers, safety instrumented systems.

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. Machine Safety. URL: http://www.schneiderelectric.fr/sites/france/fr/solutions-ts/oem/securite-machine/guide-securite.page

Semester: 9
Teaching unit: UEF 9.2 IGMF 9.4
Subject: Dynamics of rotating machines
VHS: 45h00 (Course: 1h30, Tutorials: 1h00)
Credits: 4
Coefficient: 2

Teaching objectives:

- Focusing on vibration modeling techniques for rotating machinery
- Mastering numerical solution methods and choosing the appropriate modeling
- To enable better control of the installation and use of rotating machinery
- Understanding applications on industrial machines that are particularly sensitive to vibrational alterations of their components

Recommended prior knowledge

(Mathematical calculation, prerequisites: finite elements, strength of materials and structural dynamics*).*

Content of the material:

1- Introduction to rotor dynamics: History, rotor models, characteristics of rotor elements, coordinate systems.
2- Simple rotor model: Campbell diagram, critical speeds, direct and reverse precession, symmetrical and asymmetrical rotor, instability, damped rotors.
3- Finite element modeling of rotors
4- Torsional vibrations of the rotors
5- Influence of bearings on rotor vibrations
6- Rotor balancing

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

References:

1.Lee CW, Vibration Analysis of Rotors.Dordrecht, Kluwer AcademicPublishers, 1993
2.G. Genta, Dynamics of Rotating Systems, Springer, New York, 2005

3.Friswell MI, Penny JET,Garvey SD, Lees AW, Dynamics of Rotating Machines, Cambridge University Press, 2010.
4.Lalanne M., Ferraris G., Rotordynamics Prediction in Engineering, 2nd edition, Chichester, John Wiley, 1998.
5.Krämer E. Dynamics of Rotors and Foundations, Springer-Verlag, New York, 1993
6.Childs D., TurbomachineryRotordynamics: Phenomena, Modeling, and Analysis, John Wiley & Sons, New York, NY, USA, 1993.

Semester: 9
Teaching unit: UEF 9.2IGMF 9.5
Subject: Tribology and lubrication of mechanical systems
VHS: 67h30 (Course: 1h30, Tutorials: 1h30, Practical: 1h30)
Credits: 5
Coefficient: 3

Teaching objectives:
Mastering the basic concepts of tribology. Study of friction, wear and lubrication. Modeling and solving tribological problems.

Recommended prior knowledge:
Materials, Solid Mechanics, MMC, Elasticity and Strength of Materials, Machine Elements. Course Content:

Chapter 1: Introduction. **(1 week)**
Historical background - tribology in industry - Economic considerations.

Chapter 2: Surfaces and Interfaces. **(2 Weeks)**
Definitions, concepts and criteria - Analysis and characterization of surfaces - Functional properties of surfaces - Friction and deformation of surfaces - Wear: definition and modes of wear.

Chapter 3: Friction. **(1 Week)**
Introduction - Possible causes of friction - Theory of adhesion - Presentation of theories on friction - Influence of intrinsic material properties on friction - Test methods - Choice of materials.

Chapter 4: Abrasion. **(1 Week)**
Definition and principle - Two-body abrasion - Three-body abrasion - Influence of operating parameters on abrasive wear - Influence of parameters related to abrasive particles - Influence of load - Influence of speed - Influence of environment - Influence of the nature of materials - Test methods - Choice of materials.

Chapter 5: Surface Coatings. **(2 Weeks)**
Generalities - Surface coating processes - Surface preparation - Special processes - Industrial applications.

Chapter 6: Lubrication. **(2 Weeks)**
Lubrication regimes - Hydrostatic lubrication - Hydrodynamic lubrication - Boundary (mixed) lubrication. Study of contact parameters - Pressure in the film - Load supported by the contact. Flow rate - Friction force or torque - Reynolds equation. Interpretation - Elementary load case studies. Stretching effect - Crushing effect - Oil wedge.

Chapter 7: Types and Properties of Lubricants **(1 week)**
7.1 Different types of lubrication: Gaseous, liquid, semi-solid, and solid lubricants
7.2 Lubricant components
7.3 Characteristics and properties of lubricants:
- Properties of mass, density, compressibility
- Optical properties (colors, refractive index)
- Surface properties: Surface and interfacial tension, Absorption,
- Rheological properties
- Electrical properties
- Solvent and chemical properties

7.4 Lubricant additives:

•Viscosity index additives, pour point additives, detergent and dispersant additives
•Anti-wear and extreme pressure additives, Lubricating additives, lubrication agents, extreme pressure (EP) additives, Antioxidant and anti-corrosion additives, Anti-foaming additives

Chapter 8: Industrial Classification of Lubricants (2 Weeks)
8.1 Classification by viscosity; ISO, SAE, By symbol and application and different classifications.
8.2 Lubricant selection criteria, 8.3 Lubrication processes,
8.4 Quality control of oils in service: Degradation, Lubricant contamination, Replacement frequency, Sampling, Quality control, Laboratory testing, Analytical methods,

Chapter 9: Machine Lubrication (3 Weeks)
9.1 Internal combustion engines,
9.2 Turbine,
9.3 Mechanical transmissions,
9.4 Compressors.

Evaluation method:

TP
Depending on equipment availability

Continuous assessment: 40%; Exam: 60%.

Bibliographical references:

1. Georges, Friction, wear and lubrication: Tribology or the science of surfaces, Eyrolles, 2000.
2. Hamid Zaidi, J. Rivière, Lubrication and tribology of thin coatings, Presses Polytechniques Romandes, 2010.
3. Jean-Marie Georges, Friction, Wear and Lubrication: Tribology or the Science of Surfaces, Publisher: CNRS Editions, 2000
4. Yannick Desplanques, Gérard Degallaix, Tribology and multi-physics couplings, 2006, Publisher: Presses Polytechniques et Universitaires Romandes.

Semester: 9
Methodological Unit: UEF 9.2IGMF 9.6
Subject: Ceramics
VHS: 22h30(Course: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

The objective of this teaching is to fto provide the student with practical knowledge related to the main stages of manufacturing, shaping, and consolidation by sintering of ceramics; these ceramics possess interesting physical, mechanical, and thermomechanical properties that can be controlled by the microstructure and how this can be modified to improve them.

Recommended prior knowledge:

Materials science, structure of matter.

Content of the material:

Chapter 1. Structure of ceramics (3 Weeks)
Chapter 2. Ceramics Production (3 Weeks)
Chapter 3. Classification of ceramics (3 weeks)
Chapter 4. Sintering (Mechanisms and stages of sintering) (3 weeks)
Chapter 5. Properties and behavior of ceramics (3 weeks)

Work to be carried out in parallel, depending on available resources:

♣ Effect of temperature on the viscosity of a glass.
♣ Determination of the polymorphic transformation rate of silica.
♣ Determination of the surface tension of molten silicates.
♣ Synthesis of fusible glasses of the Na2O-SiO4 and PbOSiO2 system.♣Shrinkage and swelling of clays (sheet silicates).
♣ Preparation for the installation of ceramic bricks.
♣ Cone test for the softening temperature of a ceramic.
♣ Study of plasters; (action of the fineness of the frame and of the additives on the normal consistency of the plaster paste, influence of the plasticizers on the setting and hardening, influence of the mixing water on the mechanical resistance).
♣ Particle size analysis of Portland cements, flexo metric sieving, sedimentary analysis.
♣ Influence of CaO and KOH on the setting, hardening and shrinkage of Portland cement.
♣ Implementation by vibrating table of a dense ceramic using cilica particles.

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. Boch, Philippe. "Ceramic Materials and Processes". Hermès Science Publication, 2001. ISBN 2-7462-0191-7. Paris.http://ww.hermes-science.com
2. Boch, Philippe. "Properties and Applications of Ceramics." Hermès Science Publication, 2001. ISBN 2-7462-0192-5. Paris.http://ww.hermes-science.com
3. WD Kingery, HF Bowen, DR Uhlman. “Introduction to ceramics”. Wiley.
4. IJ McColm, “Ceramic Science for Materials Technologists”. Chapman and Hall.
   Jürgen G. Heinrich, Cynthia M. Gomes, "Introduction to ceramics processing", TU Clausthal.

Semester: 9
Teaching Unit: UEM 8.1 GMF 8.8
Subject: Methods Office
VHS: 10:30 p.m. (tutorials: 1h30, 1h30 tutorials)
Credits: 1
Coefficient: 1

Teaching objectives:

The methods office constitutes the interface between the manufacturing or production workshops and the design offices. Indeed, the roles and missions of a methods department, in particular, allows for verification, in conjunction with the design office, of the feasibility and manufacturability of a product. The teaching provided aims primarily to introduce students to developing a manufacturing process, taking into account the product definition drawing, the type of production, and the resources and tools essential for its realization. The ultimate goal is for the learner to acquire the knowledge required to establish a complete product manufacturing process, particularly the design of machining sequence plans and the development of phase contracts. It is essential that these plans integrate, in accordance with production costs, the scheduling of the various machining operations and their grouping into sub-phases and phases, the judicious selection of machine tools and tooling, and the calculation of machining times.

Recommended prior knowledge:

Industrial drawing, Basic technology, Mechanical manufacturing, Materials science, Practical work in mechanical manufacturing, Conventional and Advanced Manufacturing Techniques.

Content of the material:

Course program **(1.5 hours/week)**

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

I-1 The production function.
I-1 Role and mission of a methods office.
I-2 Analysis of the definition drawing.
I-3 Concepts of form and position tolerances.
I-1 Role and mission of a methods office.

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

II-1 Taking part.
II-2 Geometric symbolization.
II-3 Choice of positioning surfaces.
II-4 Technological symbolization.
II-5 Application examples.

Chapter 3: Manufacturing Quotation **(3 weeks)**

III-1 Manufacturing dimensions: tool dimensions, machine dimensions and equipment dimensions
III-2 Transfer of dimension and orientation.
III-2 Examples of rating transfer.

Chapter 4: Elementary operations and precedence **due to constraints** *machining* **(2 weeks)**

IV -1 The basic machining operations: turning, milling, drilling, boring, gear cutting and grinding.
IV-2 Prior History due to machining constraints: dimensional, geometric and technological.

Chapter 4: Establishing a complete product manufacturing process and designing machining sequences (5 weeks)

V-1 Determination of the number of machining operations according to the quality and condition of the machined surface.
V-2 Determination of the precedence of machining operations.
V-3 Matrix method for establishing the machining order.
V-4 Grouping of machining operations in phase and sub-phase.
V-5 Machining range project.
V-6 Contract of the different machining phases and choice of cutting regime.
V-7 Drawing and production of the raw part.
V-8 Examples of machining range.

Evaluation method:

Continuous assessment: 40%, Examination: 60%

Bibliographical references:

[1]AnselmettiB., '*Tolerance Manual(Volume 4): Manufacturing dimensioning with ISO standards*',Hermes Science Publications, 2010.
[2]GaraS., '*Production engineering - Machining processes:Turning, milling, drilling, grinding*', EditionsEllipses Marketing2014
[3] Pimbaud L., Layes G., Moulin J., 'Practical guide to machining (volume 1)', Hachette Edition, 2003.
[4] Barlier C., Poulet B., 'Mechanical Production', Mémotech Collection, Casteilla Editions, 1999
[5] Chevalier A, Bohan J., Molina A., 'Practical guide to production engineering', Editions Hachette, 2000.
[6] Padilla P. and Thely A., 'Guide des Fabrications Mécaniques', Dunod, 1978.
[7] Padilla P.,AnselmettiB., Mathieu L. and Raboyeau M., 'Mechanical Production', Editions Dunod, 1986.
[8] Weill R., 'Design of machining ranges', Techniques de l'ingénieur Doc B2 025, 1993
[9] Matthieu L. and Weill R., 'A Model for Machine Tool Setting as a Function of Positioning Errors' CIRP International WorkingSeminar on Computer-Aided Tolerancing, The Pennsylvania State University, 1991.
[10] Hassin S., 'Multi-criteria qualification of machining ranges: application to aeronautical structural parts in Airware alloy', Doctoral thesis, Blaise Pascal University - Clermont-Ferrand II, 2015.

Semester: 9
Teaching Unit: UET 9.1IGMF9.10
Subject 1: Documentary research and dissertation design
VHS: 22h30(Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
To give the student the necessary tools to search for useful information in order to better utilize it in their final year project. Help him through the various stages involved in writing a scientific document. Inform the importance of communication and learn to present the work done in a rigorous and educational manner.

Recommended prior knowledge:
Writing methodology, Presentation methodology.

Content of the material:

Part I: Documentary Research:

Chapter I-1: Definition of the subject (2 Weeks)
- Subject title
- List of keywords related to the topic
- Gather basic information (acquisition of specialized vocabulary ,meaning of terms, linguistic definition)
- The information sought
- To take stock of one's knowledge in the field

Chapter I-2: Selecting information sources (2 Weeks)
- Document type (Books, Theses, Dissertations, Journal Articles, Conference Proceedings, Audiovisual Documents…)
- Type of resources (Libraries, Internet…)
- Evaluate the quality and relevance of information sources

Chapter I-3: Locate the documents (1 Week)
- Research techniques
- Search operators

Chapter I-4: Processing information (2 Weeks)
- Work organization
- The initial questions
- Summary of selected documents
- Links between different parts
- Final plan for the literature search

Chapter I-5: Presentation of the bibliography (1 Week)
- Bibliography presentation systems (The Harvard system, The Vancouver system, The mixed system…)
- Presentation of the documents.
- Citation of sources

Part II: Memory Design

Chapter II-1 Dissertation Plan and Stages **(2 Weeks)**

- Defining and delimiting the subject (Summary)
- Problem statement and objectives of the dissertation
- Other useful sections (Acknowledgments, Table of Abbreviations…)
- The introduction (The writing of*(the introduction last)*
- State of the specialized literature
- Formulation of hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- Conclusion and outlook
- Table of Contents
- The bibliography
- The appendices

Chapter II- 2 Writing techniques and standards **(2 Weeks)**

- The formatting. Numbering of chapters, figures and tables.
- The cover page
- Typography and punctuation
- Writing. Scientific language: style, grammar, syntax.
- Spelling. Improvement of general language skills in terms of comprehension and expression.
- Back up, secure, archive your data.

Chapter II-3: Workshop : Critical study of a manuscript **(Week 1)**

Chapter II-4Oral presentations and defenses **(Week 1)**

- How to present a poster
- How to present an oral communication.
- Dissertation defense

Chapter II-5: How to Avoid Plagiarism? **(Week 1)**

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

- The quote
- The paraphrase
- Provide the full bibliographic reference

Evaluation method:

Exam: 100%

Bibliographical references:

1. *M. Griselin et al., Guide to Written Communication, 2nd edition, Dunod, 1999.*
2. *JL Lebrun, Practical guide to scientific writing: how to write for the international scientific reader, Les Ulis, EDP Sciences, 2007.*
3. *HAS.Mallender Tanner, ABC of technical writing: user manuals, instructions for use, online help, Dunod, 2002.*
4. *Mr. Greuter, Writing your thesis or internship report well, L'Etudiant, 2007.*
5. *M. Boeglin, Reading and Writing at University: From the Chaos of Ideas to Structured Text. L'Etudiant, 2005.*
6. *Mr. Beaud, The Art of the Thesis, Casbah Editions, 1999.*
7. *Mr. Beaud, The Art of the Thesis, La Découverte, 2003.*
8. *Mr. Kalika, Master's thesis, Dunod, 2005.*

Semester 9
Teaching Unit: UET 2.1
Subject 1: Reverse Engineering
VHS: 45 hours (Course: 1h30and Workshop: 1h30)
Credits: 2
Coefficient: 2

Teaching objectives:

- Understanding the principles and objectives of Reverse Engineering (RE) in the field of science and technology (ST),
- To become familiar with the tools and methods of RE in the relevant specialty.
- To understand the value and ethics of RE principles in the design, manufacturing, and quality assurance of products,
- Encouraging critical thinking, technical curiosity, reasoned reverse engineering, and innovation,
- Learn to analyze, document and model an existing system without initial documentation.

Skills targeted

- Decompose and analyze an existing system,
- To faithfully reproduce a technical diagram or 3D model from an existing product,
- Apply diagnostic and simulation tools,
- Working in a group on an exploratory project,
- Identify the legal limits of reverse engineering

Adaptability to specializations within the field of Science and Technology:

- All specialties within the ST field are affected, according to
- Examples of tasks: Digital technical documentation, technology watch results, technical project management, collaboration on plans, report analysis, understanding of industrial processes, production data monitoring, reporting techniques, prototyping, testing)

Prerequisites:

–Fundamental knowledge in the specialty.

Contents of the material:

1. Introduction to Reverse Engineering

- History, legal and ethical issues of the RE,
- Definitions and fields of application: Approaches (hardware, software, processes…)
- Areas of expertise: maintenance, remanufacturing, cyber security, competitive intelligence

2. General Methodology

- Analysis of a "black box" system
- Functional decomposition
- Block diagrams, input/output diagrams, energy or information flow diagrams

3. Hardware Reverse Engineering

- Electronic boards: visual inspection, component identification
- Tools used: multimeter, oscilloscope, logic analyzer
- Electrical diagram recognition,
- Reconstructing schematics using KiCad / Proteus

4. Reverse engineering software

- Static analysis of binaries (e.g., .exe, .hex, .bin)
- Decompilation, disassembly (introduction to Ghidra, IDA Free, or Hopper)
- Behavior observation: sniffing, monitoring (e.g. Wireshark)
- Microcontroller cases: flash memory reading, firmware extraction

5. Mechanical Reverse Engineering

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

6. Security and intrusion detection

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

7. Real-world case studies

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

Examples of practical work (based on the 4 Geniuses)

- **Electrical Engineering:**

- Reverse engineering an electronic module without a schematic
- Example: Bluetooth module, time-delay relay
- Objectives: to identify the function, to draw the diagram, to propose an improved variant.
- Identification of components (ICs, transistors, resistors, etc.).
- Tools used: multimeter, oscilloscope, logic analyzer.
- Reading and extracting firmware from a microcontroller.
- Introduction to the detection of electronic counterfeits.

- **Mechanical Engineering :**

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

- **Civil Engineering:**

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

- Study of the rehabilitation or reproduction of old structural elements.

- **Process Engineering:**
- Reverse engineering of a laboratory module
- Examples: simple instruments, distillation, filtration, heat exchanger, reactor…
- Analysis of existing industrial systems (distillation column, heat exchanger, reactor…).
- Reconstruction of PFD and PID diagrams from the observation of an installation.
- Identification of sensors, actuators, control devices.
- Study of mass/energy flow in a process.

Evaluation method:

- practical techniques
- Mini reverse engineering project (report + presentation)
- Final exam (multiple-choice questions + case study)

- Exam: 60% Practical work: 40%

Bibliographical references:

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

Detailed program by subject for semester 10

Semester: 10
Teaching unit: UEF 10.1 IGMF 10
Subject: Final Year Project
VHS: 427h30 (Courses, tutorials, practical: 28h30)
Credits: 30
Coefficient: 19

Teaching objectives:

To assimilate knowledge from different subjects in a comprehensive and complementary way. To put the concepts taught during the training into concrete practice. To encourage autonomy and initiative in the student. To teach them to work collaboratively by fostering their intellectual curiosity.

Recommended prior knowledge:

The entire engineering program.

Content of the material:

The final-year engineering project should ideally focus on the design and implementation of a mechanical system or the repair and maintenance of a defective system. The topic should be chosen collaboratively by the supervising professor and a student (or group of students). The subject matter must align with the program's objectives and the student's actual abilities. Furthermore, it is preferable that the topic consider the institution's social and economic environment. When the nature of the project requires it, it may be subdivided into several parts.

Noticed :

During the period in which students are absorbing the purpose of their project and its feasibility (bibliographic research, research for software or materials necessary to carry out the project, review and consolidation of teaching directly related to the subject, etc.).

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

- The detailed presentation of the study topic, emphasizing its relevance within its socio-economic environment.
- The means implemented: methodological tools, bibliographic references, contacts with professionals, etc.
- Analysis of the results obtained and their comparison with the initial objectives.
- Criticism of the observed discrepancies and possible presentation of other additional details.
- Identifying the difficulties encountered by highlighting the limitations of the work done and the follow-up to be given to the work carried out.

The student must complete a dissertation and present it to a jury in a public defense.

Evaluation method: Final exam100%