REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE
MINISTERE DE L'ENSEIGNEMENT SUPERIEUR
ET DE LA RECHERCHE SCIENTIFIQUE

OFFRE DE FORMATION
D'INGENIEUR D'ETAT
Systèmes Autonomes
Tronc commun

Établissement :

Département :

Domaine	Filière	Spécialité
Sciences et technologie		

Responsable de l'offre de formation : ……

Table of Contents

1. Training Objectives

The objective of the "Preparatory Class in Science and Technology" is to provide students with a solid foundation in the essential scientific and technological disciplines, including mathematics, physics, and computer science, in preparation for more specialized studies in autonomous systems. This program aims to develop critical thinking, problem-solving skills, and the ability to tackle complex challenges, enabling students to smoothly transition into advanced programs in autonomous systems and related fields.

2. Target Profiles and Expected Competencies

This preparatory class targets motivated students with a strong interest in scientific and technological fields. The ideal candidates are those who have a solid background in mathematics, physics, and computer science and wish to deepen their understanding of these areas in preparation for specialized training in autonomous systems. By the end of the program, students are expected to possess essential skills in analytical thinking, scientific reasoning, and a high level of proficiency in core STEM subjects, setting them up for success in more focused training in autonomous technologies.

3. Regional and National Employability Potential

The employability potential for graduates of this preparatory class is highly promising, both regionally and nationally. With the rapid expansion of industries relying on autonomous systems such as robotics, transportation, and artificial intelligence, there is an increasing demand for highly skilled professionals. Graduates of this preparatory class will be well-positioned to enter specialized programs that lead to high-demand roles in these growing sectors, contributing to the national and regional push toward technological innovation and digital transformation.

4. Pathways to Other Specialties

The "Preparatory Class in Science and Technology" provides students with the versatility to explore various specialties after completion. While it specifically prepares students for the field of autonomous systems, the solid scientific and technological foundation allows for easy transition into other specialized areas such as robotics, artificial intelligence, data science, and even aerospace or mechanical engineering. The program equips students with the necessary skills to move toward various advanced study paths or professional careers in emerging and high-tech fields.

5. Program monitoring indicators

- Taux d’insertion professionnelle.
- Taux des vœux formulés par les étudiants pour le parcours proposé.
- Feedbacks des entreprises qui ont accueillis des stagiaires
- Feedbacks des entreprises qui ont recruté des ingénieurs issus de cette formation
- Feedbacks des étudiants en fin de cycle
- Feedbacks des étudiants en début de cycle
- Feedbacks des diplômés

6. Human resources available

A : Enrollment Capacity

200 Students

B : Academic Supervision Team

B-1 : Internal Supervision (join CV)

Nom et prénom	Spécialité	Grade	Type d'intervention	Émargement

B-2 : External Supervision (join CV)

Nom et prénom	Spécialité	Établissement d'origine	Grade	Type d'intervention	Émargement

B-3 : Comprehensive Summary of Human Resources

Grade	Effectif Interne	Effectif Externe	Total

B-4 : Permanent Support Staff (join CV)

Rank	Staff
Laboratory Engineer	**1**
Computer Engineer	**1**
Administrator	**4**
Administrative Assistant	**2**
Total	**8**

7. Available Material Resources

A- Educational Facilities

Location	Seatting Capacity	Number	Total Capacity
Lecture Hall	**200**	**4**	**800**
Tutorial Room	**30**	**15**	**450**
Practical Lab	**25**	**15**	**375**
Library	**30**	**1**	**30**
Reading Rooms	**40**	**2**	**80**
Workshop	**10**	**1**	**10**
Computer Center	**40**	**1**	**40**
Internet Room	**40**	**2**	**80**

B- Educational Laboratories and Equipment :

Laboratory Title: Physics Laboratory 1.
Student Capacity: 25.

N°	Equipement	Quantity	Operational Status
01	Force tables	01	Excellent state
02	Free Fall	04	Excellent state
03	Simple Pendulum	05	Excellent state
04	Air track »	03	Excellent state
05	PasCars	02	Excellent state
06	Torsion pendulum	02	Excellent state
07	Balance of Coulomb	05	Excellent state
08	electric field strength meter	05	Excellent state
09	Tank Rheographic	04	Excellent state
10	Analogic voltmeter	07	Excellent state
11	Analogic Ammeter	07	Excellent state

Laboratory Title: Physics Laboratory 2.
Student Capacity: 25.

N°	Equipement	Quantity	Operational Status
01	Pendule de Pohl	1	Excellent state
02	Cuve à onde	1	Excellent state
03	La corde vibrante	1	Excellent state
04	Tube de Kundt	1	Excellent state
05	Polarisation de la lumière	1	Excellent state
06	Diffraction de la lumière	1	Excellent state

Laboratory Title: Chemistry Laboratory.
Student Capacity: 25.

N°	Equipement	Quantity	Operational Status
01	Hotte	01	Excellent state
02	Etuve	01	Excellent state
03	Distillateur	01	Excellent state
04	Générateur de glace	01	Excellent state
05	Calorimètre	04	Excellent state
06	Plaques chauffantes	04	Excellent state
07	Agitateur avec chauffage	01	Excellent state
08	Balance	02	Excellent state
09	pH-mètre	04	Excellent state
10	Equipement de dosage avec pH mètre	02	Excellent state
11	Thermomètre	15	Excellent state
12	Chronomètre	06	Excellent state
13	Alimentations pour calorimétrie	02	Excellent state
14	Voltmètre pour calorimétrie	02	Excellent state
15	Ampèremètre pour calorimètre	02	Excellent state

Laboratory Title: Fluid Mechanics.
Student Capacity: 25.

N°	Equipement	Quantity	Operational Status
01	banc hydraulique numérique	01	Excellent state
02	appareils à centre de pression	02	Excellent state
03	viscosimètres à sphère tombante	02	Excellent state
04	tube de venturi	01	Excellent state
05	dispositif de décharge de l'encoche	01	Excellent state

Laboratory Title: Mechanics Laboratory.
Student Capacity: 25.

N°	Equipement	Quantity	Operational Status
01	Materials Testing Apparatus	01	Excellent state

Laboratory Title: Electricity & Electronics Laboratory.
Student Capacity: 25.

N°	Equipement	Quantity	Operational Status
01	Ampèremètre	13	Excellent state
02	Galvanomètre	02	Excellent state
03	Voltmètre	12	Excellent state
04	Wattmètre	07	Excellent state
05	Multimètre	05	Excellent state
06	Module alimentation continue pour breadboard avec transfo	06	Excellent state
07	Oscilloscopes	06	Excellent state
08	GBF	09	Excellent state
09	Alimentation stabilisée	21	Excellent state

8. Semester Teaching Organization Sheets

Semester S1 :

Teaching Unit UE	Course (h)	Tutorials (h)	Laboratory works (h)	Total (h) /week	Coeff	Credits	Continuous assignment	Final Exam
Fundamental Teaching Unit								
UEF1.1.1 Mathematics 1	**04h30**	**06h00**	**00h00**	**10h30**				
Analysis 1	01h30	03h00		04h30	5	5	40%	60%
Algebra 1	01h30	01h30		03h00	4	4	40%	60%
Probability and statistics 1	01h30	01h30		03h00	4	4	40%	60%
UEF1.1.2 Physics sciences 1	**03h00**	**04h30**	**02h00**	**09h30**				
Physics 1	01h30	03h00	01h00	05h30	5	5	40% (20% Tut+20% Lab)	60%
Chemistry 1	01h30	01h30	01h00	04h00	4	4	40% (20% Tut+20% Lab)	60%
Methodology Teaching Unit								
UEM1.1.1 Engineering tools 1	**01h30**	**03h00**	**01h00**	**05h30**				
Introduction to Programming	01h30	01h30	01h00	04h00	4	4	40% (20% Tut+20% Lab)	60%
Technical Drawing		01h30		01h30	1	1	40%	60%
Discovery Teaching Unit								
UED1.1.1 Engineering			**01h00**	**01h00**				
Linux Discovery 1			01h00	01h00	1	1	100%	
Cross-Disciplinary Teaching Unit								
UET1.1.1 Human sciences and languages 1	**01h30**	**01h30**	**00h00**	**03h00**				
General Economy	01h30			01h30	1	1		100%
English 1		01h30		01h30	1	1	40%	60%
Total (h)/week	**10h30**	**15h00**	**04h00**	**29h30**				
Total / Semester					**30**	**30**		

Semester 2

Teaching Unit UE	Course (h)	Tutorials (h)	Laboratory works (h)	Total (h) /week	Coeff	Credits	Continuous assignment	Final Exam
Fundamental Teaching Unit								
UEF1.2.1 Mathematics 2	**04h30**	**06h00**	**00h00**	**10h30**				
Analysis 2	01h30	03h00		04h30	5	5	40%	60%
Algebra 2	01h30	01h30		03h00	4	4	40%	60%
Probability and statistics 2	01h30	01h30		03h00	4	4	40%	60%
UEF1.2.2 Physics sciences 2	**03h00**	**04h30**	**02h00**	**09h30**				
Physics 2	01h30	03h00	01h00	05h30	5	5	40% (20% Tut+20% Lab)	60%
Chemistry 2	01h30	01h30	01h00	04h00	4	5	40% (20% Tut+20% Lab)	60%
Methodology Teaching Unit								
UEM1.2.1 Engineering tools 2	**01h30**	**01h30**	**02h30**	**05h30**				
Algorithms and data structures	01h30	01h30	01h00	04h00	4	4	40% (20% Tut+20% Lab)	60%
Computer Aided Design			01h30	01h30	1	1	100%	
Discovery Teaching Unit								
UED1.2.1 Engineering	**00h00**	**00h00**	**01h00**	**01h00**				
Linux Discovery 2			01h00	01h00	1	1		
Cross-Disciplinary Teaching Unit								
UET1.2.1 Human sciences and languages 2	**01h30**	**01h30**	**00h00**	**03h00**				
Human Engineering	01h30			01h30	1	1		100%
English 2		01h30		01h30	1	1	40%	60%
Total (h)/week	**10h30**	**13h30**	**05h30**	**29h30**				
Total / Semester					**30**	**30**		

Semester 3

Teaching Unit UE	Course (h)	Tutorials (h)	Laboratory works (h)	Total (h) /week	Coeff	Credits	Continuous assignment	Final Exam
Fundamental Teaching Unit								
UEF2.1.1 Mathematics 3	**03h00**	**03h00**	**00h30**	**06h30**				
Analysis 3	01h30	01h30		03h00	3	3	40%	60%
Numerical Analysis 1	01h30	01h30	00h30	03h30	3	3	40% (20% Tut+20% Lab)	60%
UEF2.1.2 Physics sciences 3	**03h00**	**03h00**	**01h00**	**07h00**				
Physics 3	01h30	01h30	00h30	03h30	4	4	40% (20% Tut+20% Lab)	60%
Chemistry 3	01h30	01h30	00h30	03h30	3	3	40% (20% Tut+20% Lab)	60%
UEF2.1.3 Engineering sciences 1	**04h30**	**04h30**	**01h00**	**10h00**				
Mechanics of Rigid bodies 1	01h30	01h30		03h00	3	3		
General Electricity	01h30	01h30	00h30	03h30	4	4	40% (20% Tut+20% Lab)	60%
Fluid Mechanics	01h30	01h30	00h30	03h30	3	3	40% (20% Tut+20% Lab)	60%
Methodology Teaching Unit								
UEM2.1.1 Engineering tools 3	**01h30**	**01h30**	**00h30**	**03h30**				
Advanced Data Structures and Algorithms	01h30	01h30	00h30	03h30	3	3	40% (20% Tut+20% Lab)	60%
Discovery Teaching Unit								
UED2.1.1 Engineering	**01h30**	**01h30**	**00h30**	**03h30**				
Digital Logic and Combinational Circuits ls	01h30	01h30	00h30	03h30	3	3		
Cross-Disciplinary Teaching Unit								
UET2.1.1 Human sciences	**01h30**			**01h30**				
Entrepreneurship	01h30			01h30	1	1		100%
Total (h)/week	**15h00**	**13h30**	**03h30**	**32h00**				
Total / Semester	**225.00**			**487.50**	30	30		

Semester 4

Teaching Unit UE	Course (h)	Tutorials (h)	Laboratory works (h)	Total (h) /week	Coeff	Credits	Continuous assignment	Final Exam
Fundamental Teaching Unit								
UEF2.2.1 Mathematics 4	**03h00**	**03h00**		**06h30**				
Analysis 4	01h30	01h30		03h00	3	3	40%	60%
Numerical Analysis 2	01h30	01h30	00h30	03h30	3	3	40% (20% Tut+20% Lab)	60%
UEF2.2.2 Physics sciences 4	**03h00**	**03h00**	**01h00**	**07h00**				
Physics 4	01h30	01h30	00h30	03h30	4	4	40% (20% Tut+20% Lab)	60%
Chemistry 4	01h30	01h30	00h30	03h30	3	3	40% (20% Tut+20% Lab)	60%
UEF2.2.3 Engineering sciences 2	**04h30**	**04h30**	**01h00**	**10h00**				
Mechanics of Rigid bodies 2	01h30	01h30		03h00	3	3		
General Electronics	01h30	01h30	00h30	03h30	4	4	40% (20% Tut+20% Lab)	60%
Strength of materials	01h30	01h30	00h30	03h30	3	3	40% (20% Tut+20% Lab)	60%
Methodology Teaching Unit								
UEM2.2.1 Engineering tools 3	**01h30**	**01h30**	**00h30**	**03h30**				
Object-Oriented Programming	01h30	01h30	00h30	03h30	3	3	40% (20% Tut+20% Lab)	60%
Discovery Teaching Unit								
UED2.2.1 Engineering	**01h30**	**01h30**	**00h30**	**03h30**				
Digital Systems and Sequential Circuits	01h30	01h30	00h30	03h30	3	3	40% Lab (20% Tut+20% Lab)	60%
Cross-Disciplinary Teaching Unit								
UET2.2.1 Human sciences	**01h30**	**00h00**	**00h00**	**01h30**				
Ethics and deontology	01h30			01h30	1	1		100%
Total (h)/week	**15h00**	**13h30**	**03h30**	**32h00**				
Total / Semester					**30**	**30**		

9. Mode d’évaluation

Donner quel sont les moyens d'évaluations (Examen, Control continu, Devoir, Travaux pratiques, Stages, Mini Projet, Projet de fin d’étude…)

Donner les formules pour le calcul de la note de la matière, note éliminatoire…

10. Programme détaillé par matière

Lister les matières

Matière xxxx Code: yyyyy
……
……

Semester 1

Teaching Unit	Subject Title	Code	Semester
UEF1.1.1	Analysis 1	ANA1	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	03H00	01H30	00H00	5

Objective

Prerequisites

Basic knowledge of mathematics

Content

Chapter 1: Sets of Real Numbers (4 weeks)

1. Reminder of reasoning by induction and by contradiction
2. The sets $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{Q}$ and $\mathbb{R}$
3. Absolute value, fundamental inequalities, intervals, and neighborhoods.
4. Definitions of upper-bounded and lower-bounded sets. The supremum, infimum, maximum, and minimum
5. Characterization of the supremum
6. The floor function

Chapter 2: Sequences of Real Numbers (4 weeks)

1. Definitions and examples of sequences (Arithmetic sequences, geometric sequences, recursive sequences).
2. Definitions of increasing, decreasing, bounded, convergent, and divergent sequences.
3. Limit of a real sequence (finite and infinite limits)
4. Criteria for convergent sequences (limit of a positive sequence, monotone sequences, squeeze theorem, adjacent sequences)
5. Subsequences
6. Recursive sequences

Chapter 3: Real Functions of a Real Variable (5 weeks)

1. Definitions and general concepts (Domain of definition, even functions, odd functions, periodic functions, bounded functions, monotone functions)
2. Limits (definition of a limit at a point, left-hand and right-hand limits, limit at infinity)
3. Operations on limits
4. Continuity (functions continuous at a point, functions continuous on an interval, examples of continuous and discontinuous functions)
5. Theorem on continuous functions on a closed interval (functions continuous on a closed and bounded interval, intermediate value theorem, monotonic bijection theorem)
6. Differentiability (derivative of a function at a point, differentiable functions on an interval, differentiability and continuity, operations on differentiable functions, derivative of the inverse function)
7. Extrema
8. Rolle's Theorem and the Mean Value Theorem

Chapter 4: Common Functions (2 weeks)

1. The natural logarithm ln(x), the exponential function ee^x, and powers a^x
2. Trigonometric functions and their inverses
3. Hyperbolic functions and their inverses

Assessment Methods

- Regular in class assessments (40%).
- Final exam (60%).

References

1- F. Ayres Jr, Théorie et Applications du Calcul Différentiel et Intégral - 1175 exercices corrigés, McGraw-Hill.
2- F. Ayres Jr, Théorie et Applications des équations différentielles - 560 exercices corrigés, McGraw-Hill.
3- J. Lelong-Ferrand, J.M. Arnaudiès, Cours de Mathématiques - Equations différentielles, Intégrales multiples, Tome 4, Dunod Université.
4- M. Krasnov, Recueil de problèmes sur les équations différentielles ordinaires, Edition de Moscou
5- N. Piskounov, Calcul différentiel et intégral, Tome 1, Edition de Moscou
6- J. Quinet, Cours élémentaire de mathématiques supérieures
7- J. Dixmier, Cours de mathématiques du premier cycle. 1ère année. Gauthiers-Villars. Paris 1976
8- R. Murray Spiegel. Théorie et applications de l'Analyse. McGraw-Hill, Paris 1973

Teaching Unit	Subject Title	Code	Semestre
UEF1.1.1	Algebra 1	ALG1	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H00	4

Objective

– Ensure a smooth transition to higher education by building on and expanding the knowledge acquired in high school.
– Strengthen students' training in logic, reasoning, and calculation techniques, which are essential tools for both mathematics and other scientific disciplines and introduce algebraic structures.
– Present new and rich concepts to spark students' interest.

Prerequisites

Basic knowledge of mathematics.

Content

Chapter 1: **Logic, Sets, and Applications (Lectures: 07h30, Tutorials: 07h30)**
– Mathematical Propositions.
– Quantifiers.
– Types of Mathematical Reasoning.
– Sets (definitions).
– Operations (union, intersection, complement, symmetric difference, Cartesian product).
– Subsets of a Set.
– Applications (definitions).
– Operations (composition, addition, etc.).
– Direct Image, Inverse Image.
– Injection, Surjection, Bijection, and Inverse Application.

Chapter 2: **Binary Relations (Lectures: 0 3h00, Tutorials: 03h00)**
– Binary Relations: Definitions (Properties of Binary Relations),
– Order Relations, partial order, total order
– Equivalence Relations and equivalence classes

Chapter 3: Algebraic Structures (Lectures: 04h30, Tutorials: 03h00)
– Internal Composition Laws (Binary operation).
– Groups, Subgroups.
– Rings, Subrings.
– Fields, Subfield
– Application: Field of Complex numbers.

Chapter 4: **Polynomial Rings (Lectures: 06h00, Tutorials: 04h30)**
– Definition (without construction). Examples (Z[X], IR[X], and C[X]).
– Euclidean Division and Division by Increasing Powers of Polynomials.
– Roots of a Polynomial.
– Factorization of Polynomials over IR and C.
– GCD. Bézout's Theorem and Gauss's Theorem.

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

1. A. KUROSH, *Cours d’algèbre supérieure*. Edition MIR MOSCOU.
2. D. FADEEV and I. SOMINSKY, *Recueil d'exercices d’algèbre supérieure*. Edition MIR MOSCOU.
3. J. RIVAUD, *Exercices avec solutions tome 1*. VUIBERT.
4. J. RIVAUD, *Exercices avec solutions tome 2*. VUIBERT.
5. LEBSIR HABIB, *Travaux dirigés d’algèbre générale*. Dar el-Houda Ain M'LILA.
6. Jean-Pierre ESCOFIER, *Toute l’algèbre de la licence. Cours et exercices corrigés*. DUNOD.
7. J. Lelong-Ferrand, J.M. Amaudiès, *Cours de mathématiques. Tome 1 Algèbre 3°édition. Classes préparatoires 1°cycle universitaire*. DUNOD.

Teaching Unit	Subject Title	Code	Semester
UEF1.1.1	Probability and Statistics	STAT	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H00	4

Objective

This module introduces students to essential concepts in probability and statistics, including:

- One- and two-variable statistical series,
- Probability on finite universes,
- Random variables.

Prerequisites

Programming basics acquired in Math 1 and Math 2.

Content

Part A: Statistics

Chapter 1: Basic Definitions (1 week)

A.1.1 Concepts of population, sample, variables, and modalities.
A.1.2 Types of statistical variables: qualitative, quantitative, discrete, continuous.

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

A.2.1 Frequency, relative frequency, percentage.
A.2.2 Cumulative frequency and cumulative relative frequency.
A.2.3 Graphical representations: bar chart, pie chart, stick diagram, frequency polygon, histogram, cumulative curves.
A.2.4 Measures of central tendency.
A.2.5 Measures of dispersion: range, variance, standard deviation, coefficient of variation.
A.2.6 Measures of shape.

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

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

Part B: Probability

Chapter 1: Combinatorial Analysis (1 week)

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

Chapter 2: Introduction to Probability (2 weeks)

B.2.1 Algebra of events.
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 Conditioning.

B.3.2 Independence.
B.3.3 Bayes' theorem.

Chapter 4: Random Variables (1 week)
B.4.1 Definitions and properties.
B.4.2 Cumulative distribution function.
B.4.3 Mathematical expectation.
B.4.4 Covariance and moments.

Chapter 5: Common Discrete Probability Distributions (1 week)
Bernoulli, binomial, Poisson, etc.

Chapter 6: Common Continuous Probability Distributions (2 weeks)
Uniform, normal, exponential, etc.

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

1) Pierre Dagnélie. Theoretical and Applied Statistics. De Boeck Université, 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-Making: Theory and Business Applications. P. Lang, 2000.
5) Sheldon M. Ross. Introduction to Probability. Presses Polytechniques et Universitaires Romandes, 2007.
6) Gilbert Saporta. Probability, Data Analysis, and Statistics. Technip, 1990.

Teaching Unit	Subject Title	Code	Semester
UEF1.1.2	Physics I: Mechanics of particles	PHY1	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	03H00	01H30	00H50	5

Objective

This course provides an introduction to the fundamental concepts of classical mechanics, which describe the motion of objects under the influence of forces. It should provide students with a foundation in classical introductory physics topics such as kinematics, Newton's laws of motion, energy, rotational dynamics, and the concepts of inertia and conservation laws. In addition it introduces core concepts such as space, time, mass, force, momentum, angular momentum, and torque.

The primary goal of this course is to develop a conceptual understanding of various physical phenomena and the ability to apply theoretical frameworks to describe and predict the motion of bodies.

Students learning outcomes: After completing this course, students will be able to:

- Express quantities of measurement, and Apply dimensional analysis concepts to perform unit conversions.
- Explain and use vector algebra.
- Demonstrate knowledge of equations of one and two dimensional motion by applying kinematic equations.
- Demonstrate knowledge of Newton’s three laws of motion, energy, momentum, angular momentum.
- Central force motion.
- Planetary motion and rockets.
- Single Oscillators: harmonic oscillations.
- Demonstrate an understanding of kinetic, potential energy, and work by analyzing and solving work-energy problems.
- Understand the conservation laws governing physical systems
- Apply conservation of momentum concepts to collisions.
- Demonstrate understanding of physical rotational motion situations by applying rotational kinematic equations and angular momentum concepts to rotational motion problems.
- Distinguish between collisions in which momentum is conserved and when it is not.

Prerequisites

First derivatives, Partial derivative, Integral calculus, Basic understanding of vectors and trigonometry

Content

Chapter 1: Physical Quantities, **Units, Dimensional Analysis, and Estimation**

- Overview of mechanics, the different branches of physics.
- Dimensions of Fundamental and Derived Quantities.
- International System of Units.
- Dimensional analysis.
- Quantifying uncertainty in Measured Quantities.
- Concept of direction.
- Scalars and vectors.

- Vector Analysis, Addition of vectors, Components of a vector, Addition of several vectors, Scalar product, and Vector product.
- Reference Frames, Coordinate systems.
- Gradient, Divergence and Curl.

Chapter 2: One Dimensional Kinematics, Rectilinear motion.

- Introduction
- Time and Space
- Kinematic quantities: Locating a Point "Position", Time Interval, Displacement, Velocity, Acceleration.
- Equations of motion for constant acceleration.
- Graphical representation of motion.
- Vector representation of velocity and acceleration.
- Simple Motions.
- One Dimensional Kinematics and Integration.

Chapter 3: Two Dimensional Kinematics, Curvilinear motion

- Introduction to the Vector Description of Motion in Two Dimensions.
- General curvilinear motion in a plane Cartesian coordinates, Polar coordinates and intrinsic coordinates, Tangential and normal components of acceleration.
- Motion in a Plane **"**Projectile Motion", Equation of path or trajectory.

Chapter 4: Rotational Kinematics "Circular Motion"

- Introduction.
- Velocity and Angular Velocity.
- Tangential and Radial Acceleration.
- Period and Frequency for Uniform Circular Motion.
- Angular Velocity and Angular Acceleration.

Chapter 5: Three Dimensional Kinematics.

- Displacement, Velocity, Acceleration in the Cylindrical coordinates
- Displacement, Velocity, Acceleration in the Spherical coordinates.

Chapter 6: Relative Motion.

- Introduction.
- Absolute and relative frame of references.
- Law of Addition of Displacements.
- Law of Addition of Velocities.
- Law of Addition of Accelerations.

Chapter 7: Newton's Laws of Motion.

- Introduction.
- Quantity of Matter, Definition of Mass and System.
- Linear momentum (Quantity of Motion), Principe of conservation of momentum.
- Newton's First Law, the law of inertia.
- Newton's Second and Third Laws, concept of force.
- Free-body Force Diagram.
- Gravitational Force near the Surface of the Earth, Frictionless Free Fall and Frictional Free Fall.
- Types of forces: Contact Forces, Frictional forces, Kinetic and Static Friction, Drag Forces in Fluids, Hooke's Law, Coulomb's Law, Tension in a Rope, Central forces.

- Systems with variable mass
- Simple Harmonic Motion, Periodic Motion, General Solution of Simple Harmonic Oscillator Equation, Simple Pendulum.

Chapter 8: The Concept of Energy and Conservation of Energy.

- The Concept of Energy and Conservation of Energy.
- Work done by a Force.
- Kinetic Energy and Work-Kinetic Energy Theorem.
- Conservative and Non-Conservative Forces and Potential Energy..
- Mechanical Energy and Conservation of Mechanical Energy.
- Definition of Power Applied by a Force.

Chapter 9: Collision Theory

- **I**ntroduction.
- Conservation of momentum in isolated systems.
- Elastic Collisions and Inelastic Collisions.
- One-Dimensional Collisions Between Two Objects.
- Two Dimensional Elastic Collisions Between Two Objects.

Laboratory work

- Forces tables and uncertainty
- Free Fall
- Projectile motion
- Pendulum motion and conservation of mechanical energy
- Air Track and collision
- Torsion pendulum

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

- Classical Mechanics, 3rd edition, John R. Taylor, University Science Books, ISBN-13: 978-1891389221.
- Halliday, David; Resnick, Robert (1970). Fundamentals of Physics. John Wiley & Sons. Chapters 1–21. Numerous subsequent editions.
- Fundamental university physics Volume 1: Mechanics (Addison-Wesley series in physics) Hardcover – January 1, 1967 by Marcelo Alonso (Author), Edward J. Finn.
- Kibble, T. W.; Berkshire, F. H. (2004). Classical Mechanics. Imperial College Press. ISBN 1860944248.
- Kleppner, Daniel; Kolenkow, Robert (1973). An Introduction to Mechanics. McGraw-Hill. ISBN 0-07-035048-5.
- Morin, David (2005). Introduction to Classical Mechanics: With Problems and Solutions. Cambridge University Press. ISBN 9780521876223.
- Müller-Kirsten, Harald J.W. (2024). Classical Mechanics and Relativity (2nd ed.). World Scientific. ISBN 9789811287114.
- Taylor, John (2005). Classical Mechanics. University Science Books. ISBN 978-981-12-8711-4.

- Young, Hugh D.; Freedman, Roger A. (2019). University Physics with Modern Physics (15th ed.). Pearson. ISBN 978-0135159552.

Teaching Unit	Subject Title	Code	Semester
UEF1.1.2	Chemistry 1	CHM1	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	4

Objective

Prerequisites

Content

Chapter I : Generalities (Lecture : 01h30, Tutorial : 01h30)

- The aspects of matter
- Homogeneous and heterogeneous mixtures
- Pure body : simple and compound
- Atom and molecule

Chapter II : The main constituents of matter (Lecture : 03h00, Tutorial : 03h00)

- **Constituents of atom**
  a) Electron : Brief description of the techniques of highlighting this particle
  b) The nucleus : Rutherford experiment
  c) Proton : The nuclear reaction
  d) Neutron : Chadwick experiment
- **The characteristics of atom**
  a) The atomic number
  b) The mass number
  c) The isotopes : Definition, average atomic mass, isotopic abundance (percentage)
  d) The separation of isotopes : Spectrometry of Bainbridge and Dempster

Chapter III : The electronic Structure of the atom (Lecture : 10h30, Tutorial : 10h30)

- Electromagnetic radiation and emission spectrum of hydrogen atom: theory of quanta, wave-particle duality, photoelectric effect, continuous and discontinuous spectrum
- Bohr's atomic model: Description, postulates, calculations in the case of hydrogen atom, interpretations of the lines of hydrogen emission spectrum, calculations in the case of hydrogen-like ions and the shortcomings of Bohr's model
- Atomic model in quantum mechanics : Duality wave-particle and De Broglie equation, Heisenberg's indeterminacy principle, SCHRÖDINGER equation: Equation, wave function, probability presence density, normalization condition, application linear potential box, proper functions and proper values of Hamiltonian operator, generalization to three dimensional box.
- Hydrogen atom and hydrogen-like-ion in quantum mechanics : Schrödinger Equation in function of spherical coordinates , the three quantum numbers, concept of atomic orbital, radial and angular parts of the wave function, radial probability density, representation of atomic orbitals type s and p.
- Generalization to polyelectronic atoms: J.C. Slater hydrogen-like approximation, the fourth quantum number

- Electron configuration of atoms : PAULI exclusion principle, energetic stability principle and KLECHKOWSKI rule , HUND's rule, exceptions of filling rules, electron structures of noble gases, valence electrons and core electrons, dia and paramagnetic properties, electron structures of ions.
- Periodic classification of elements :
    a) Periodic table : Forms, Periods, groups and chemical families, blocks, ,metals, non-metals, transition metals, semimetals,...
    b) Evolution and periodicity of physical and chemical properties :
    i) Atomic and ionic radii: atomic radius, covalent radius, ionic radius, calculation of radii according to Slater approximation, variation of radius in the periodic table, comparison between atomic, anionic and cationic radii
    ii) Ionization energy: Definition of different forms of ionization energy, calculation of ionization energy according to Slater approximation, change of ionization energy in the periodic table
    iii) Electron affinity: Definition and evolution
    iv) Electronegativity: Definition and evolution, Electronegativity scales (Pauling scale, Mulliken scale and the scale of Allred and Rochow.

Chapter IV : Molecule electron structure– chemical bond (Lectures : 07h30, Tutorial : 07h30)

- **The classical theory :**
    a) The theory of Lewis – Kossel – Langmuir : Lewis diagrams, the octet rule, the most stable ions of elements
    b) Covalent bond : Definition, simple bond, double bond , triple bond , coordination bond, valence, Lewis representations.
    c) Polarization of covalent bonds – Partial ionic character: dipole momentum, Partial ionic character and its evolution in function of electronegativity difference, polar and non-polar molecules
    d) V.S.E.P.R theory : Different Gillespie rules, arrangement of electron pairs and geometries of chemical species, comparison between bond angles.
    e) Shortcomings Lewis model
- **The quantum theory:**
    f) L.C.A.O. method Representation of bonding and antibonding orbitals : radial and angular representations. Energies of bonding and antibonding orbitals, Order, bond length and energy
    g) Types of overlapping of atomic orbitals : axial overlapping (σ bond) lateral overlapping (π bond)
    h) Atomic orbital diagrams: Diatomic molecules , homonuclear and heteronuclear molecules
    i) Polyatomic molecules – Theory of hybridization : hybridizations sp, sp^2, sp^3

Laboratory work

– Laboratory work 1 : General recommendations in terms of safety of working
- Laboratory work 2: Preparation of solutions
– Laboratory work 3: Quality control of products (Milk, vinegar, bleach,…)
– Laboratory work 4: Illustration of V.S.E.P.R theory using molecular models

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).

- Final exam (60%).

References

– Chimie tout en un PCSI, B. Fosset, éditions Dunod.
– Chimie générale, J. Hill, éditions ERPI.
– Chimie générale, McQuerrie, éditions De Boeck.

Teaching Unit	Subject Title	Code	Semester
UEM1.1.1	Introduction to Programming	ITP	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	01H00	4

Objective

- Have an overview of the architecture of a computer.
- Master the practice of the four operations in base 2, 8 and 16.
- Develop algorithmic reasoning to help solve different problems
- Use the tools of the C language to implement algorithmic solutions.
- Master the basic notions of programming such as conditional and iterative actions.
- Know how to use tables, strings, and structures (records) to store and manipulate various data.

Prerequisites

- None

Content

Chap1: Composition of a computer (PW: 01h30)

Chap2: Representation of numbers (PW: 01h30)
- Numbering systems: decimal, binary, octal and hexadecimal.
- Decimal-binary and binary-decimal conversions.
- Binary arithmetic: addition, subtraction, multiplication, division

Chap3: Basic notions of the C language (Course: 3h00, DW: 3h00)
- Algorithm and Program
- My first C program
- Structure of a C program.
- Constant and variable, expression
- Precedence of operators
- Basic actions: Assignment, display, reading

Chap4: Conditional structures: if-else, switch **(Course: 3h00, DW: 3h00)**
Chap5: Iterative structures: for, while, do-while **(Course: 6h00, DW: 6h00)**
Chap6: One-dimensional arrays (Course: 3h30, DW: 4h30)
Chap7: Two-dimensional arrays (Course: 3h00, DW: 3h00)
Chap8: Strings (Course: 2h30, DW: 1h30)
Chapter 9: Structures. (Course: 1h30, DW: 1h30)

Laboratory work

- **PW 1:** Familiarization with the C development environment, basic actions **(3h00)**
- **PW 2:** Conditional structures **(03h00)**
- **PW 3:** Iterative structures. **(04h30)**
- **PW 4:** One-dimensional arrays. **(04h30)**
- **PW 5:** Manipulation of two-dimensional arrays, string, structure. **(03h00)**

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

- GAUDEL, M., Soria, M., and Froidevaux, C. (1987). Types de données et algorithmes. Number vol. 1 in Collection didactique. Institut national de recherche en informatique et en automatique.
- CORMEN, T., LEISERSON, C., RIVEST, R., and CAZIN, X. (1994). Introduction à l'algorithmique. Science informatique. Dunod.
- CORMEN, T. (2013). Algorithmes : Notions de base. Informatique. Editions DUNOD.

Teaching Unit	Subject Title	Code	Semester
UEM1.1.1	Technical Drawing	TD	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30		00H00	1

Objective

The Technical Drawing course aims to provide students with a comprehensive understanding of technical drawing fundamentals, enabling them to create accurate drawings using various instruments and software while applying ISO standards. This course prepares students to apply technical drawing principles in real-world applications, laying a solid foundation for further studies or professional practice.

Targeted Skills

- Understand the fundamentals of technical drawing and its importance in engineering and architecture.
- Develop skills in using drawing instruments and software to create accurate technical drawings.
- Apply ISO standards and conventions in technical drawings.
- Enhance problem-solving skills through project-based learning.

Prerequisites

Basic geometric shapes

Content

Chapter 1: Introduction to Technical Drawing (1h30)

- Overview of Technical Drawing
- Drawing Instruments and Techniques
- Safety and Ergonomics

Chapter 2: Geometrical Constructions (03h00)

- Geometric Nomenclature
- Elemental Construction Principles
- Polygon Construction
- Circular Construction

Chapter 3: Descriptive Geometry (03h00)

- Plans of projection
- Projection of Point
- Projections of Straight Lines
- Projections of Plan

Chapter 4: Orthographic Projection (06h00)

- Orthographic view
- Methods of Orthogonal Projection
- Necessary Views
- Projection of Cylinders
- Projection of Inclined Surfaces
- Basic Shape

Chapter 5: Pictorial Drawing (3h00)

- Isometric Drawing
- Axonometric Drawings
- Perspective Drawings

Chapter 6: Dimensioning and Tolerancing (1h30)

- Introduction
- Dimensioning Components
- Dimensioning Methods

Chapter 7: Sectioning Techniques (3h00)

- Introduction to Sectioning
- Sectional Views and Hatching
- Conventional Representations

Chapter 8: Assembly Drawings (1h30)

- Introduction to Assembly Drawings
- Advanced Assembly Techniques
- Project-Based Assembly Drawing

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

- A. Chevalier ; « Guide du dessinateur industriel »; hachette technique; Paris, 2011.
- A. Ricordeau, C. Corbet ; « Dossier de technologie de construction »; Casteilla; Paris, 2001.
- A. Ricordeau; « Géométrie descriptive appliquée au dessin »; Casteilla; Paris, 2009.
- C. Corbet, B. Duron ; « Lire le dessin technique »; Casteilla; Paris, 2005

Teaching Unit	Subject Title	Code	Semester
UED1.1.1	Linux Discovery 1	LIN1	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	00H00	00H00	01H00	1

Objective

The objective of this course is to familiarize students with key Linux concepts through hands-on practice. Students will get hands-on experience of managing the Linux operating environment, file and permission management, as well as process and user management. The entire program is based on practical work to enable students to apply the principles directly in a real Linux environment.

Prerequisites

None

Content

- **Lab 0:** Installing Linux and Initial Setup
  - Introduction to different Linux distributions.
  - Installing Linux
  - Basic post-installation setup (user creation, updating the system).
- **Lab 1:** Introduction to Linux and Navigation
  - Understanding the Linux environment (graphical vs. command-line).
  - Basic terminal commands (pwd, ls, cd, mkdir, rm).
  - Exploring the Linux file system hierarchy (/home, /etc, /var).
  - Use find and grep to locate files in the system.
- **Lab 2:** File Management and Permissions
  - Creating and modifying files (nano, vim, touch).
  - File operations (cp, mv, rm, cat, less).
  - Understanding and modifying permissions (ls -l, chmod, chown).
  - Create a shared file with restricted access.
- **Lab 3:** Process and User Management
  - Listing and managing processes (ps, top, kill).
  - Managing users and groups (whoami, id, adduser, usermod).
  - Setting up a new user with restricted permissions.

Assessment Methods

- Laboratory reports and practical assignments (100%).

References

- W. Shotts, The Linux Command Line: A Complete Introduction, 3rd ed., No Starch Press, 2021.
- C. Negus, Linux Bible, 11th ed., Wiley, 2022.
- A. Tanenbaum & H. Bos, Modern Operating Systems, 4th ed., Pearson, 2014.
- R. Love, Linux System Programming: Talking Directly to the Kernel and C Library, 2nd ed., O'Reilly Media, 2013.

Teaching Unit	Subject Title	Code	Semester
UET1.1.1	General Economy	ECO	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	00H00	00H00	1

Objective

- Acquérir les concepts fondamentaux liés au fonctionnement de l'entreprise ;
- Prendre de la complexité de l'environnement de l'entreprise ;
- Sensibiliser l'étudiant à l'entrepreneuriat.

Prerequisites

Economie générale, culture générale

Content

Chap. 1 : Introduction à l'entreprise (03h00)

- Définition
- critères de classification des entreprises
- statut juridique des entreprises
- L'environnement de l'entreprise (interne et externe)
- Les structures organisationnelles

Chap. 2 : Les fonctions de l'entreprise (03h00)

- Fonction marketing,
- Fonction production,
- Fonction approvisionnement,
- Fonction recherche et développement,
- Fonction comptabilité et finance,
- Fonction administration.

Chap. 3 : Etude de marché (03h00)

- Définition
- Principaux axes de l'étude de marché
- Elaboration d'une stratégie marketing

Chap. 4 L'entreprise sociétale (03h00)

- Économie verte et protection de l'environnement
- développement durable (activité, emploi et métiers liés à la croissance verte)

Assessment Methods:

- Final exam (100%).

References

- Richard Soparnot (2012) Organisation et gestion de l'entreprise, Edition Dunod
- Cédric Chevauché, (2014), L'indispensable pour créer son entreprise, Edition le puits fleuri
- Jacques Igalens (2012), La Responsabilité Sociale des Entreprises. Défis, risques et nouvelles pratiques, Edition Eyrolles

Teaching Unit	Subject Title	Code	Semester
UET1.1.1	English 1	ENG1	1

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30		00H00	1

Objective

This course aims to develop students' English language skills in the context of robotics and artificial intelligence. Through reading, listening, discussions, and vocabulary-building activities, students will enhance their understanding of technical concepts while improving their grammar, writing, and communication abilities. The course also focuses on essential technical skills, such as using dictionaries, recognizing computer components, preparing presentations, and writing structured essays. By the end of the course, students will be able to effectively communicate technical ideas and apply their language skills in academic and professional settings.

Prerequisites

A foundational understanding of English, including reading, writing, and speaking skills.

Content

Week	Unit	Activity Type	Topic	Grammar Focus/ Writing activities	Technical Skills
1	**Unit 1: Robotic Arms**	Reading & Discussion & Vocabulary	Article on Robotic arms	Present simple & Pronunciation of final s	Naming computer components
2		Listening & Discussion & Vocabulary	Video on Robotic arms	Parts of speech & writing a complete sentence.	
3	**Unit 2: Artificial Intelligence**	Interactive lecture on AI	Text on Artificial Intelligence	Conjunctions & writing a paragraph	Using a monolingual dictionary Using Microsoft word
4		Listening & Discussion & Vocabulary	Video on Artificial Intelligence	Future simple & preparing an essay outline	
5	**Unit 3: Embodied intelligence**	Reading & Discussion & Vocabulary	Article on Embodied intelligence	Writing an essay	Using Microsoft Power point
6		Listening & Discussion & Vocabulary	Video on Embodied intelligence	Tips for a successful presentation	
7	**Final Presentations**	Student Presentations	Summary of Learnings	—	Application of Course Skills

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

1. Cannon, J. E., Fredrick, L. D., & Easterbrooks, S. R. (2010). Vocabulary instruction through books read in American Sign Language for English-language learners with hearing loss. Communication Disorders Quarterly, 31(2), 98-112.
2. Louie, B., & Sierschynski, J. (2015). Enhancing English learners' language development using wordless picture books. The Reading Teacher, 69(1), 103-111.
3. Kedley, K. E. (2015). Queering the teacher as a text in the English Language Arts classroom: beyond books, identity work and teacher preparation. Sex Education, 15(4), 364-377.
4. Jafari Pazoki, S., & Alemi, M. (2020). Engineering students' motivation to learn technical English in ESP courses: Investigating Iranian teachers' and students' perceptions. RELC Journal, 51(2), 212-226.
5. Khan, S., Taj, S., & Maroof, R. Y. (2021). Effectiveness of CLT in developing technical English writing skills at undergraduate level in the context of Pakistan. FWU Journal of Social Sciences, 15(1), 81-89.
6. Staugaard Jr, A. C. (1987). Robotics and AI: an introduction to applied machine intelligence. Prentice-Hall, Inc.
7. Bartneck, C., Lütge, C., Wagner, A., & Welsh, S. (2021). An introduction to ethics in robotics and AI (p. 117). Springer Nature.
8. Mair, G. M. (1988). Industrial robotics. Prentice Hall.
9. Merat, F. (1987). Introduction to robotics: Mechanics and control. IEEE Journal on Robotics and Automation, 3(2), 166-166.
10. Watson, D. P., & Scheidt, D. H. (2005). Autonomous systems. Johns Hopkins APL technical digest, 26(4), 368-376.

Semester 2

Teaching Unit	Subject Title	Code	Semester
UEF1.2.1	Analysis 2	ANA2	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	03H00	01H30	00H00	5

Objective

Prerequisites

Analysis 1

Content

Chapter 1: Taylor's Expansion and Limited development (3 weeks)

1. Taylor's theorem with Lagrange remainder, Taylor's theorem with Young's remainder, and their applications.
2. Limited development (n-th order limited development at the neighborhood of 0. Uniqueness. Common limited development obtained using Taylor's theorem. Operations on limited development)
3. Applications of limited development (Applications of limited development in calculating equivalences and limits of functions presenting indeterminate forms, determination of the equation of the tangent and the asymptote)

Chapter 2: Integral and Primitive (4 weeks)

1. Riemann integral (Definition of the Riemann integral. Definition using Riemann sums. Definition using step functions)
2. Primitive (Primitive of a continuous function)
3. Calculation of primitives (Primitives of common functions. General formulas).
4. Integration methods (Integration by parts, variable change)
5. Integration of rational fractions
6. Integration of rational functions (in sin, cos, tan, sinh, cosh, and tanh)
7. Integration of trigonometric functions

Chapter 3: Ordinary Differential Equations (3 weeks)

1. First-order ordinary differential equations
    - General definitions
    - Separable and separable-variable equations
    - First-order linear differential equations (Homogeneous and non-homogeneous)
    - Solving some non-linear differential equations (Bernoulli equation, Ricatti equation, Lagrange equation
2. Second-order linear differential equations with constant coefficients
3. Some examples of second-order differential equations with variable coefficients

Chapter 4: Multivariable functions (3 weeks)

1. Definitions and representations
    - Domain of definition, graph, and level curves
    - Examples: functions from $\mathbb{R}^2$ to $\mathbb{R}$
2. Limits and continuity
    - Concept of limit for a function of several variables
    - Continuity and properties

3. Partial derivatives and differentiability
    - Partial derivatives and geometric interpretation
    - Gradient of a function
    - Differentiability
    - Taylor's theorem for functions of two variables
4. Extrema and applications
    - Hessian matrix and second derivative test
    - Local and global extrema
    - Lagrange multipliers for constrained extrema

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

1. F. Ayres Jr, Théorie et Applications du Calcul Différentiel et Intégral - 1175 exercices corrigés, McGraw-Hill.
2. F. Ayres Jr, Théorie et Applications des équations différentielles - 560 exercices corrigés, McGraw-Hill.
3. J. Lelong-Ferrand, J.M. Arnaudiès, Cours de Mathématiques - Equations différentielles, Intégrales multiples, Tome 4, Dunod Université.
4. M. Krasnov, Recueil de problèmes sur les équations différentielles ordinaires, Edition de Moscou
5. N. Piskounov, Calcul différentiel et intégral, Tome 1, Edition de Moscou
6. J. Quinet, Cours élémentaire de mathématiques supérieures
7. J. Dixmier, Cours de mathématiques du premier cycle. 1ère année. Gauthiers-Villars. Paris 1976
8. R. Murray Spiegel. Théorie et applications de l'Analyse. McGraw-Hill, Paris 1973

Teaching Unit	Subject Title	Code	Semester
UEF1.2.1	Algebra 2	ALG2	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H00	4

Objective

- Consolidate the knowledge acquired in the 1st semester.
- Study new concepts: sum of several vector subspaces, stable subspaces, trace.
- Transition from the geometric register to the matrix register and vice versa.

Prerequisites

– Basic knowledge of mathematics, and Algebra 1.

Content

Chapter 1: **Vector Spaces (Lectures: 04h30, Tutorials: 04h30)**
- Definition (over IR, and C).
- Vector Subspaces (Definition, Proprieties)
- Sum and direct sum of Subspaces.
- Complementary Subspaces.
- Linearly Independent Family. Linearly Dependent Family. Bases (finite).

Chapter 2: **Linear Maps (Lectures: 03h00, Tutorials: 03h00)**
- Definition (operations).
- Kernel and Image.
- Rank of a Linear Map.
- Rank Theorem.
- Characterization of Injection, Surjection, and Bijection.

Chapter 3: **Matrices, Associated Matrices, and Determinants (Lectures: 10h30, Tutorials: 07h30)**
- Definition (as a table of numbers). Special Matrices.
- Operations on Matrices. The Vector Space of Matrices.
- Determinants (definition (order 2, 3, and generalization) and properties).
- Invertible Matrix.
- Matrix Representation of a Linear Map.
- Correspondence between Operations on Linear Maps and Those on Matrices.
- Change of Basis Matrix (Transition Matrix).
- Effect of a Change of Basis on the Matrix of Linear Maps.

Chapter 4: **Systems of Linear Equations (Lectures: 03h00, Tutorials: 03h00)**
- Definitions and Interpretations.
- Cramer's Systems (general case).
- Gaussian Elimination Method.

Chapter 5: **Matrix Reduction (Lectures: 06h00, Tutorials: 06h00)**
- Eigenvalues, Eigenvectors, Eigenspaces
- Characteristic Polynomials. Cayley-Hamilton Theorem.
- Characterization of Diagonalizable Matrices.
- Power of Matrices, Exponential of Matrices, Applications.

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

- A. KUROSH: *Cours d'algèbre supérieure*. Edition MIR MOSCOU.
- D. FADEEV and I. SOMINSKY: *Recueil d'exercices d'algèbre supérieure*. Edition MIR MOSCOU.
- J. RIVAUD: *Exercices avec solutions tome 1*. VUIBERT.
- J. RIVAUD: *Exercices avec solutions tome 2*. VUIBERT.
- LEBSIR HABIB: *Travaux dirigés d'algèbre générale*. Dar el-houda Ain M'LILA.
- Jean-Pierre ESCOFIER: *Toute l'algèbre de la licence. Cours et exercices corrigés*. Dunod.
- J. LELONG-FERRAND, J.M. ARMAUDIÈS: *Cours de mathématiques. Tome 1 Algèbre 3°édition. Classes préparatoires 1°cycle universitaire*. Dunod.
- A. DONEDDU: *ALGEBRE ET GEOMETRIE 7 Mathématiques spéciales Premier cycle universitaire*. VUIBERT.
- COLLET Valérie: *MATHS Toute la deuxième année. ellipses.

Teaching Unit	Subject Title	Code	Semester
UEF121	Probability	PROBA	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H00	4

Objective

- Conduct probabilistic analysis of random variables and compare with statistical approaches.
- Utilize probability tables for common distributions.
- Study the dependence between two random variables.

Prerequisites

- Probability component from Semester 1.

Content

Chapter I: Real Random Variables (Lectures: 10h30, Tutorials: 9h00)

1. Introduction and definitions.
2. Discrete case analysis.
3. Common discrete probability distributions.
4. Continuous case analysis.
5. Common continuous probability distributions.

Chapter II: Random Couples (Lectures: 15h00, Tutorials: 9h00)

1. Introduction
   1.1 Definitions and concepts.
   1.2 Cumulative distribution function.
2. Discrete Case
   2.1 Joint probability distribution.
   2.2 Marginal distributions.
   2.3 Cumulative distribution function of a pair.
   2.4 Conditional random variables.
   2.5 Independence.
3. Absolutely Continuous Case
   3.1 Joint density function.
   3.2 Marginal densities.
   3.3 Cumulative distribution function.
   3.4 Random variables.
   3.5 Independence.
4. Characteristics of a Random Couple
   4.1 Mathematical expectation.
   4.2 Decomposition of expectation.
   4.3 Covariance of a pair.
   4.4 Correlation coefficient.
5. Transformation of a Random Couple
   - Discrete and continuous cases.

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

- K. Redjdal, Cours de probabilités (Probability Course), OPU, 2005.
- P. Bogaert, Probabilités pour scientifiques et ingénieurs (Probability for Scientists and Engineers), Boeck, 2006.
- R. Veysseire, Statistique et probabilités pour l'ingénieur (Statistics and Probability for Engineers), Dunod, 2006.

Teaching Unit	Subject Title	Code	Semester
UEF1.2.2	Physics 2. Electricity and Magnetism	PHY2	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	03H00	01H30	00H50	5

Objective

A course designed to introduce students to electrical and magnetic phenomena in nature, including the concepts of electrical charges, Coulomb's law, Superposition principle, Concept of electric field, and magnetic fields and their origin, the application of Gauss' Law, electric potential, conductors and insulators, currents, basic circuits, Ohm's law, Faraday's law, and Lenz's law.

Student learning outcomes: After completing this course, students should be able to:

- Recognize electric field concept, coulomb's law and superposition principle and solve problems in electrostatics.
- Apply Gauss's law to solve problems in electrostatics.
- Have knowledge on the meaning of electric potential, equipotential surfaces, and calculate potential for different charge distributions.
- Apply the concept of electric potential to calculate work done in assembling point charges and continuous charge distributions.
- Recognize the basic properties of conductors and calculate the capacitance of different capacitors, charging and discharging of RC Circuit.
- Apply Ohm's Law to solve simple electrical circuits.
- Use Kirchhoff's laws to solve more complex electrical networks (with two or more Emf's).
- Determine the force due to a magnetic field (B) on a charge q moving with velocity v.
- Determine the force between current-carrying conductors.
- Explain the origin of magnetic field and magnetic forces. In addition, Calculate Magnetic field due to current source employing Biot-Savart and Ampere's laws.
- Apply Faraday's law, and Lenz's law of electromagnetic induction

Prerequisite

Dot products, and Cross products, Differential calculus: Gradient, Divergence, Curl, Second derivatives, Integral calculus, curvilinear coordinates, Polar coordinates, Spherical coordinates, Cylindrical coordinates.

Content

Chapter zero: Reviews on Scalar and vector fields

- Vector Analysis.
- Functions of several variables.
- Partial derivative and Total differential.
- Gradient, Divergence and Curl.

Chapter 1: Coulomb's law

- Source of electricity, Electric Charge.
- Electrostatic force, Coulomb's law, Principle of Superposition.
- Electric fields due to Point Charges and continuous charge distributions (Volume, Surface, and Line Charge Density), Electric Field Lines.

- Electric potential and Potential Energy, Electric Potential due to Point Charges, Potential Energy in a System of Charges, Continuous Charge Distribution, Deriving Electric Field from the Electric Potential and Vice-versa, Work Done on Charges, Gradient and Equipotentials.
- Electric Potential and Field of a Dipole, Dipole in Electric Field, Potential Energy of an Electric Dipole.
- Electric Flux, Gauss's law and its applications.

Chapter 2: Conductors and Dielectrics

- Force on a Conductor, Field of a conductor, and Electrostatic Energy of a charged uniform sphere.
- Capacitors in Electric Circuits, Parallel Connection, Series Connection, Equivalent Capacitance, Storing Energy in a Capacitor, Energy Density of the Electric Field.
- Dielectrics, Polarization, Capacitance with Dielectrics, Equivalent Capacitance, Energy Density in a Capacitor with a Dielectric.

Chapter 3: Resistance, and Direct-Current Circuits

- Electric current, Current Density, Voltage, Ohm's law, resistivity and conductivity, Drift Velocity, Electrical Energy and Power, Power Loss.
- Electromotive Force Emf, internal resistance and terminal potential difference of a battery.
- Resistors in Series and in Parallel, Equivalent Resistance.
- Kirchhoff's Circuit Rules, Voltage-Current Measurements, RC circuits Charging and Discharging a Capacitor.

Chapter 4: Magnetic Field, Lorentz and Laplace forces, Biot-Savart and Ampere Laws

- Definition of a Magnetic Field B, Sources of Magnetic Fields.
- Force Exerted by a Magnetic Field on a Moving Charge q with velocity v, Lorentz Force, Magnetic Force on a Current-Carrying Wire, Laplace force, Force Between Two Parallel Conductors, Torque on a Current Loop.
- Biot-Savart and Ampere's Law, Magnetic Field Inside and Outside a Current-Carrying Wire, Magnetic Field due to a Circular Current Loop, Magnetic Field of the Helmholtz Coils, Solenoid.

Chapter 5: Faraday's and Lenz's Laws of Induction

- Magnetic Flux, Faraday's laws and Lenz's Law.
- Motional EMF, EMF Due to a Time-Varying Magnetic Field.
- Induced Electric Field, Rectangular Loop Near a Wire, Loop Changing Area, Sliding Rod, Moving Bar.
- Time-Varying Magnetic Field, RC Circuit in a Magnetic Field.
- Alternating-Current Generator.
- Mutual M and Self L Induction.

Laboratory work

- Balance of Coulomb
- Equipotential surfaces and electric field lines (Rheographic Tank)
- Electric field strength meter
- Oscilloscope: RC circuit and RLC circuit applications
- Passive dipoles, upstream and downstream configuration
- Electromagnetic field measurements.

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

- J. Walker, R. Resnick, D. Halliday, Fundamentals of Physics (10th edition) [Science QC21.3.H35 2014].
- E.M. Purcell, Electricity and Magnetism [Science QC21.2.B474 vol. 2].
- Cutnell, and Johnson; "Physics "; 8th Edition, 2009. ISBN 978-0-470-22355-0.
- Introduction to Electrodynamics (3rd Edition), David J. Griffiths, Cambridge University Press; 4th edition (2017). ISBN: 978-1108420419.
- J. D. Jackson, Classical Electrodynamics.
- R.P. Feynman, R.B. Leighton, M. Sands, The Feynman Lectures on Physics, volume II [Science 530 F438F vol. 2]

- **Internet Sources:**

1. An online suite of resources: www.wiley.com/college/wileyplus
2. Self-assessment: www.wiley.com/college/cutnell
3. Online lectures: http://academicearth.org/courses/fundamentals-of-physics
4. Online tutorials: http://www.dmoz.org/Science/Physics/Education/Tutorials/

Teaching Unit	Subject Title	Code	Semester
UEF1.2.2	Chemistry 2	CHM2	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	4

Objective

Content

CHAPTER I : General concepts in thermodynamics (Lecture :06h00, Tutorial : 06h00)

1. Introduction thermodynamics :

a) Definitions : open, closed and isolated systems, thermoplastic, state variables, state functions, intensive and extensive quantities, reversible and irreversible transformations

b) Behaviour of gases at low pressure **:** Clapeyron diagram,, variation of Amagat coordinates in function of pressure, absolute scale of temperatures

c) Ideal gas model Ideal gas equation of state, Boyle-Mariotte law, Charles law , Gay-Lussac law ; mixtures of gases : number of moles, molar fraction, partial pressure (Dalton law)

d) Real gases : Comparison between ideal gas and real gas, Van Der Waals equation

2. Energy exchanges

a) Heat and energy : Concept of temperature and thermal equilibrium : Zero temperature principle, different kinds of energy, heat with change in temperature, heat transfer, heat capacity, heat with state change, latent heat, measures of heat and calorimetry,

b) Mechanical work achieved by pressure force

CHAPTER II : The first law in thermodynamics (lectures : 04h30, Tutorial : 04h30)

1. Statement of the law – Concept of internal energy : Conservation of internal energy, state function, exact total differential, case of a cycle, case of an isolated system

2. Concept of enthalpy: Expression, differential of H_3. Transformations at constant volume and at constant pressure : Q_V and Q_P

4. Application of 1^{st} law on ideal gas: Joule's law, Mayer equation, different types of transformations: isothermal, adiabatic, isochoric, isobaric

CHAPTER III : The second law in thermodynamics (Lectures : 04h30, Tutorial : 04h30)

1. Introduction

2. Statement of the law – Concept of entropy

3. Reversible and irreversible transformations: Sytem entropiy, external entropy, total entropy, exchange entropy, created entropy

4. Calculation of entropy variations in the case of ideal gas for the known 4 transformations

5. Study of Carnot cycle: expressions of W, Q, ΔU et ΔS, cycle efficiency, reversible cycle, thermal engines (ditherms), heat pumps,…

6. Mixture entropy: Case of gases with similar nature and with different nature

7. Variations of entropy in case of state change

8. Statistical considerations of entropy Concept of disorder, Boltzmann equation, Nernst principle and the third law in thermodynamics absolute entropy

CHAPTER IV : Application 1^{st} and 2^{nd} laws in thermodynamics in chemical reactions-Thermochemistry (Lectures : 06h00, Tutorial : 06h00)

1. Thermochemistry relative to 1st law

a) Reaction heat :

i) Heat at constant pressure, heat at constant volume : Expressions, relation between the two heats of reaction, reaction enthalpies, exothermic reactions , endothermic reactions

ii) Standard state

iii) Standard formation enthalpy

b) Determination of reaction enthalpies

i) Measures of reaction enthalpies by calorimetry

ii) Indirect determination of reaction enthalpies: Hess law

iii)Influence of the temperature on the reaction enthalpy : Kirchhoff equation

c) Bond enthalpies: Enthalpy or energy of bond formation, bond dissociation enthalpy (energy) , reaction enthalpy in function of bond energies

2. Reaction entropy

Application of Hess law and Kirchhoff equation

CHAPTER V : Free enthalpy-free energy (Lecture : 01h30, Tutorial : 01h30)

1. Free enthalpy: Definition, function of Gibbs, spontaneity condition
2. Free energy : Expression, Helmholtz function, spontaneity condition
3. Calculation of free enthalpy during chemical reactions: Expression, free energy of formation
4. Molar free enthalpy: Case of pure gas (supposed ideal), case of a mixture of gases, chemical potential

Laboratory work

– Laboratory work 1 : Phase change

- Laboratory work 2: Ideal gas equation demonstration (Boyle-Mariotte law)

– Laboratory work 3: Calorimetry 1: Determination of the water value of calorimeter- determination of specific heat of a metal- determination of latent heat

– Laboratory work 4: Determination of a compound formation enthalpy by calorimetry

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

- Thermodynamique chimique, M. Chabanel, éditions Ellipses.
- Thermodynamique, R. Gaboriaud, éditions Ellipses.
- Thermodynamique PCSI MPSI PTSI, 1ère année - Edition Aout 2007 ; Collection : Classe Prépa (Auteur) M. Pullicino.
- Exercices corrigés de thermodynamique MPSI-PCSI-PTSI : Fiches, méthodes et exercices corrigés 1ère année, Xavier Ducros ; Date de parution : 29/06/05 ; Editeur : Ellipses Marketing ; Collection : Taupe-Niveau ; ISBN : 2-7298-2519-3
- Thermodynamique. Cours et exercices corrigés, 1ère année MPSI-PCSI PTSI (Broché) ; Jean-Robert Seigne

Teaching Unit	Subject Title	Code	Semester
UEM1.2.1	Algorithms and Data Structures	ADS	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	01H00	4

Objective

- Plan and design a program using structured development techniques.
- Predict, design, create, and use functions by breaking down a problem into subtasks.
- Pass arguments by address or value between functions.
- Write valid programming statements to declare, initialize, manipulate, and pass pointers as arguments to functions.
- Use and explain the relationship between pointers and the values they indicate.
- Use and manipulate data structures

Prerequisites

Introduction to programming

Content

Chap. 1: Predefined functions: processing strings, processing character shapes, mathematical functions, generating random numbers. **(Course: 01h30)**

Chap. 2: Functions (Course: 06h00)
- Introduction: function with and without return (procedure)
- Concept of pointer, transmission of parameters by value/address
- Local variable and global variable
- default parameters, function overloading, Pre-declaration of functions

Chap. 3: Recursive functions. (Course: 3h00)
- Examples of recursive and iterative functions.
- Trace of execution of a recursive function
- Terminal / non-terminal recursive
- Passage of recursive function into iterative function.
- Passage of iterative function into recursive function.

Chap. 4: Pointers and dynamic memory allocation. (Course: 1h30)

Chap. 5: Linked linear lists. (Course: 7h30)
- Concepts and implementations, operations: traversal, creation, insertion, deletion.

Chap. 6: Files (Course: 3h00)
- Usefulness of files, File types, use of files.

Laboratory work

- Practical work 1: Predefined functions **(3h00)**
- Practical work 2: Modularity: creation of programs using functions with different types of parameter passing. **(06h00)**
- Practical work 3: Recursion: creation of a program using the concept of recursion. **(01h30)**
- Practical work 4: Pointers and dynamic memory allocation. **(03h00)**
- Practical work 5: List manipulation: creation of list manipulation tools, such as creation, insertion, deletion. **(06h00)**
- Practical work 6: File manipulation **(3h00)**

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

- GAUDEL, M., Soria, M., and FROIDEVAUX, C. (1987). Types de données et algorithmes. Number vol. 1 in Collection didactique. Institut national de recherche en informatique et en automatique.
- SEDGEWICK, R. (1991). Algorithmes en langage C. I.I.A. Informatique intelligence artificielle. Dunod.

Teaching Unit	Subject Title	Code	Semester
UEM1.2.1	Computer Aided Design	CAD	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	00H00	00H00	01H30	1

Objective

a way to digitally create 2D drawings and 3D models of real products before they are even manufactured

Prerequisites

CONCEPT ON TECHNICAL DRAWING

Content

Construction of scketchs –Volme drawing – Assemblage- Surface drawing- mise en plan

Assessment Methods:

- Laboratory reports and practical assignments (100%).

References

M Groover- E Zimmers CAD/CAM Computer aided design and manufacturing
Aleksander SADOWSKI / Free CAD Beginners starter Kit

Teaching Unit	Subject Title	Code	Semester
UED1.2.1	Linux Discovery 2	LIN2	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	00H00	00H00	01H00	1

Objective

This course builds on the basic principles introduced in Linux Discovery 1 and covers more advanced system administration tasks. Students will get hands-on practice with software installation, shell scripting and automation using Linux services. Through hands-on lab sessions, students will gain skills in managing system processes, scheduling tasks and achieving maximum productivity in a Linux environment.

Prerequisites

- Linux Discovery 1

Content

- **Lab 1:** Introduction to Shell Scripting and Software Management
  - Installing and removing software packages (apt, dnf).
  - Writing basic shell scripts (echo, if, for, chmod +x).
  - Automating a simple task using a shell script.
- **Lab 2:** Linux Services Management
  - Introduction to Linux services (systemctl list-units --type=service).
  - Starting, stopping, and restarting a service (systemctl start/stop/restart).
  - Managing essential system services (cron, cups).
- **Lab 3:** Task Automation with cron
  - Scheduling automatic tasks with crontab.
  - Creating and testing a maintenance script.
  - Verifying the execution of automated scripts.

Assessment Methods:

- Laboratory reports and practical assignments (100%).

References

- W. Shotts, The Linux Command Line: A Complete Introduction, 3rd ed., No Starch Press, 2021.
- C. Negus, Linux Bible, 11th ed., Wiley, 2022.
- A. Tanenbaum & H. Bos, Modern Operating Systems, 4th ed., Pearson, 2014.
- R. Love, Linux System Programming: Talking Directly to the Kernel and C Library, 2nd ed., O'Reilly Media, 2013.

Teaching Unit	Subject Title	Code	Semester
UET1.2.1	Human Engineering	HING	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	00H00	00H00	1

Objective

- Développement et apprendre les concepts clés de l'existence de l'ingénieur en vue d'être acteur humaniste innovant.

Prerequisites

Content

Chap. 1 : Les outils méthodologiques dans l'analyse des situations professionnelles et humaines (03h00)
- Sociométrie
- Psychologie de travail

Chap. 2 : L'éthique de l'ingénieur (03h00)
- Définition de l'éthique
- Rapport ingénieur-éthique
- Autonomie
- Responsabilité
- Citoyenneté
- Professionnalisation du métier
- Conscience de soi et de l'autre
- Créativité

Chap. 3 : Développement personnel et professionnel (04h30)
- Déontologie du métier
- Développement personnel
- Développement collectif
- Initiative pour une culture d'innovation durable

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

- Christelle Didier (2008) Les ingénieurs et l'éthique : Pour un regard sociologique
- Arnaud Berger Nicolas PERIN, (2014), Le développement durable, Edition Nathan
- Yvette Veyret et Jacqueline Jalta (Auteur), Développements durables : Tous les enjeux en 12 leçons, édition Autrement

Teaching Unit	Subject Title	Code	Semester
UET1.2.1	English 2	ENG2	2

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30		00H00	1

Objective

This course is designed to introduce students to the core areas of their future specializations in autonomous systems engineering. The three units of the course—Robotics and Autonomous Systems Design (RASD), Unmanned Systems Navigation and Control (USNC), and Autonomous Embedded Systems Engineering (AESE)—serve as an exploration of the key principles, technologies, and applications within these fields. By providing students with foundational knowledge and hands-on activities, this course aims to familiarize them with the topics they will delve deeper into during their next academic year. Through reading, listening, and discussion activities, combined with
practical skill-building in grammar and technical tools, students will gain a clearer understanding of their future career paths and be better prepared for their specialization.

Prerequisites

A foundational understanding of English, including reading, writing, and speaking skills.

Content

Week	Unit	Activity Type	Topic	Grammar Focus	Technical Skills
1	**Unit 1: Robotics and Autonomous Systems Design (RASD)**	Reading & Discussion & Vocabulary	Text on RASD	Present Continuous	How to conduct a search on Google, Google Scholar, and Google Books.
2		Listening & Discussion & Vocabulary	Manual on RASD (Read instructions)	Clauses (Cause, Effect, Contrast, Addition)	
3	**Unit 2: Unmanned Systems Navigation and Control (USNC)**	Reading & Discussion & Vocabulary	Text on USNC	Past Simple vs. Present Perfect & write instructions	Sending an email using Gmail
4		Listening & Discussion & Vocabulary	Video on USNC	Active vs Passive voice & write an email	
5	**Unit 3: Autonomous Embedded Systems Engineering (AESE)**	Reading & Discussion & Vocabulary	Text on AESE	Present perfect continuous vs past continuous	Improving typing speed using typing test.com
6		Listening & Discussion & Vocabulary	Video on AESE	Conditional Sentences	Sharing tips on developing soft skills

7	**Final Presentations**	Student Presentations	Summary of Learnings	—	Application of Course Skills

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

1. Mark Ibbotson, Professional English in Use: Engineering – Technical English for Professionals, 2009.
2. Nick Brieger, Alison Pohl, Technical English Vocabulary and Grammar, Year Unknown.
3. Prof. Ravindra Nath Tiwari, Technical English 1, 2019.
4. Wong, C., Yang, E., Yan, X. T., & Gu, D. (2017, September). An overview of robotics and autonomous systems for harsh environments. In 2017 23rd International Conference on Automation and Computing (ICAC) (pp. 1-6). IEEE.
5. Araujo, H., Mousavi, M. R., & Varshosaz, M. (2023). Testing, validation, and verification of robotic and autonomous systems: a systematic review. ACM Transactions on Software Engineering and Methodology, 32(2), 1-61.
6. Kendoul, F. (2012). Survey of advances in guidance, navigation, and control of unmanned rotorcraft systems. Journal of Field Robotics, 29(2), 315-378.
7. Christophersen, H. B., Pickell, R. W., Neidhoefer, J. C., Koller, A. A., Kannan, S. K., & Johnson, E. N. (2006). A compact guidance, navigation, and control system for unmanned aerial vehicles. Journal of aerospace computing, information, and communication, 3(5), 187-213.
8. Becker, L. B., Farines, J., Bodeveix, J., Filali, M., & Vernadat, F. (2010). Development process for critical embedded systems. WSE 2010, Gramado. Anais. Porto Alegre: SBC, 95-108.
9. Vernadat, F. Verification Based Development Process for Embedded Systems.

Semester 3

Teaching Unit	Subject Title	Code	Semester
UEF 2.1.1	Analysis 3	ANA 3	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H00	3

Objective

Have a very good command of the techniques for calculating double and triple integrals as well as line integrals and surface integrals. Then, have the basic knowledge about numerical series, sequences and series of functions. In particular, power series

Prerequisites

Analysis 1 & 2. Algebra 2

Content

Chapter 1 : Double and triple integrals

Double integrals (definition, properties, variables change, calculus of area and moments)

Triple integrals (definition, properties, variables change, calculus of volume and moments)

Chapter 2 : Vector analysis

Vector calculus (curl, divergence, conservative vector fields)

Line integrals (definition, properties and applications)

Surface integrals (definition, properties, Green's formula and applications)

Divergence theorem (Stokes theorem, Ostrogradski theorem)

Chapter 3 : Numerical series

Definition and operations on numerical series

Convergence of numerical series

Convergence criteria for positive series

Leibniz and Abel criterion

Chapter 4 : Sequences and series of functions

Sequences of functions (definition, pointwise and uniform convergence, limit passage theorems) Series of functions (definition, pointwise convergence, uniform convergence, absolute convergence, normal convergence, limit passage theorems).

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

1- J. Lelong-Ferrand, J.M. Arnaudiès, Cours de Mathématiques - Equations différentielles, Intégrales multiples, Tome 4, Dunod Université.

2- N. Piskounov, Calcul différentiel et intégral, Tome 1, Edition de Moscou

3- J. Quinet, Cours élémentaire de mathématiques supérieures 3- Calcul intégral et séries, Dunod.

4- James Stewart, Calculus, Cengage learning

Teaching Unit	Subject Title	Code	Semester
UEF 2.1.1	Numerical Analysis 1	NUM1	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	3

Objective

The course presents numerical methods for the solution of mathematical problems such as non-linear equations and systems of linear equations, functions approximation, integration and differentiation, and differential equations.

Prerequisites

Mathematics 1 and 2, Computer Science 1 and 2.

Content

Chapitre 1: Solutions of Nonlinear Equations in One Variable (6 hours)

1. Floating-Point Numbers, Roundoff Errors, Loss of Significance, Stable and Unstable Computations.
2. Solution of Nonlinear Equations:
   - Root-finding problem: Locating Roots, Bracketing Method and Open Method.
   - Bisection Method.
   - Fixed Point Iteration.
   - Newton-Raphson Method.
   - Secant Method.
   - False Position Method.

Chapitre 2: Polynomial Interpolation (9 hours)

1. Introduction and Errors in Polynomial Interpolation.
2. Interpolation Polynomials:
   - Lagrange form of Interpolation Polynomial.
   - Newton form of Interpolation Polynomial.
   - Chebyshev Polynomials: Choosind Nodes and Convergence.
3. Divided Differences:
   - Algorithm for Divided Differences.
   - Difference Calculus.
4. Hermite Interpolation:
   - Direct Method.
   - Hermite Universal Matrices.
5. Spline Interpolation.
6. Inverse Interpolation.

Chapitre 3: Approximation of Functions (6 hours)

1. Least Squares Approximation Problem.
2. Orthogonal polynomials.
3. Minimax Approximations.
4. Trigonometric Approximation.

Laboratory work

- Prise en main de Matlab
- Résolution des équations non-linéaires

- Résolution des systèmes linéaires : Méthodes directes
- Résolution des systèmes linéaires : Méthodes itératives

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

1) Won Young Yang, Wenwu Cao, Tae-Sang Chung, APPLIED NUMERICAL METHODS USING MATLAB, John Wiley end Sons (2005).
2) William Ford, NUMERICAL LINEAR ALGEBRA WITH APPLICATIONS USING MATLAB, Elsevier Inc (2015).
3) Cleve B. Moler, NUMERICAL COMPUTING WITH MATLAB, Siam (2004).
4) Grégoire Allaire, Sidi Mahmoud Kaber, NUMERICAL LINEAR ALGEBRA, Springer (2008).
5) Nicholas J. Higham, ACCURACY AND STABILITY OF NUMERICAL ALGORITHMS, siam (1996).

Teaching Unit	Subject Title	Code	Semester
UEF 2.1.2	Physics 3	PHY3	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	4

Objective

- Introduction to Lagrangian formalism.
- Study of free, forced, and damped vibrations.
- Analysis of coupled oscillators and normal modes.

Prerequisites

- Mechanics: Newton's laws, harmonic oscillator, friction forces, calculation of kinetic and potential energies.
- Mathematics: Second-order differential equations, complex exponential functions.

Content

Chapter 1: General Concepts of Oscillations (2 weeks)

1. Mathematical Review
2. General Definitions
   - Coordinates, degrees of freedom.
   - Kinetic energy, potential energy, total energy.
   - Conservative systems.
   - Dissipative systems.
3. Equilibrium State
   - Stable equilibrium.
   - Unstable equilibrium.
4. Oscillations
   - Newton's method.
   - Angular momentum method.
   - Principle of total energy conservation.

Chapter 2: Free vibration of undamped single degree of freedom systems (3 weeks)

1. Definitions and Properties
   - Lagrange-Euler formalism.
2. Application Examples
   - Mechanical oscillators: vertical mass-spring system, horizontal mass-spring system, pendulums (simple and compound).
   - Electrical oscillators: LC circuit model.
3. Energy Analysis

Chapter 3: Damped free vibration of single degree of freedom (3 weeks)

1. Definitions and Properties
   - Equation of motion:
     - Viscous friction force.
     - Solid-solid friction force.
   - Electromechanical equivalence.
   - Pseudo-periodic motion.
   - Critically damped motion.
   - Aperiodic motion.
2. Logarithmic Decrement
3. Energy Analysis

Chapter 4: Forced vibration of damped single degree of freedom systems (3 weeks)

1. Definitions and Properties
   - Equation of motion under a sinusoidal force: transient and steady-state regimes.
2. Mathematical Solutions
   - Strong damping case.
   - Critical damping case.
   - Weak damping case.
   - Undamped case.
3. Resonance Phenomenon
4. Concept of Impedance
5. Bandwidth and Quality Factor
6. Energy Analysis
   - Equation of motion for arbitrary excitation.
7. Electromechanical Equivalence
8. Application Examples
   - Engine vibrations.
   - Loudspeaker vibrations.
   - Seismograph.

Chapter 5: Free and forced vibration of two degree of freedom systems (4 weeks)

1. Definitions
   - Simple uncoupled systems.
   - Complex coupled systems.
2. Types of Coupling
3. Case Study: Two Free Coupled Mechanical Systems
   - System of differential equations.
   - Linear systems.
   - Concept of natural frequencies.
   - General solutions.
4. Identical Coupled Systems
   - Beating phenomenon.
   - Principle of superposition.
   - Forced coupled systems.
   - Concepts of resonance and anti-resonance.
5. Electromechanical Equivalence
6. Technical Applications
   - Vehicle vibrations.
   - Dynamic dampers.

Laboratory work

- Forced oscillations: Pohl’s pendulum.
- Study of free and forced oscillations in an RLC circuit.
- Coupled pendulums.

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

1. H. Djelouah; *Vibrations et Ondes Mécaniques*; Office des Publications Universitaires.

2. Jean-Paul Pérez - *Vibrations et Ondes: Cours et exercices corrigés*.
3. *Ondes et physique moderne*, M. Séhuin, éditions De Boeck.

Teaching Unit	Subject Title	Code	Semester
UEF 2.1.2	Chemistry 3: Electrochemitry	CHM3	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	3

Objective

Electrochemistry plays a crucial role in several practical applications and research. This discipline has regained prominence due to its involvement in innovative technologies such as energy production and storage. In order to enhance their efficiency and duration, autonomous systems such as unmanned vehicules (UVs) often use electrochemical batteries as energy sources as well as electrochemical fuel cells. Furthermore, another important applications related to UVs missions such chemicals detection are mainly based on electrochemical sensors.

The aim of this matter is to acquire basic concepts of electrochemistry and electrochemical thermodynamics necessary to the comprehension of electrochemical phenomena and applications (galvanic cells, batteries, electrolysers…)

Prerequisites

The students should have a certain level of knowledge on basic electric circuits, matter structure, chemical bonds, thermodynamics, chemical equilibrium, equilibrium constant.

Content

Chapter I : Solution chemistry (5 weeks)

1- **General informations about solutions**

- Definition of a solution
- Quality and quantity aspects of solution
- Activity, activity coefficient, Debye-Huckel Theory
- Ionisation coefficient
- Chemical kinetics (fundamental concepts) : concentration evolution in function of time

2- **Acids and Bases**

- Definitions of acids and bases (according to: Bronstedt- Lewis –Arrhenius).
- Strength of acids and bases-concept of pK_a - predominance range
- Concept of pH , buffer solutions

3- Precipitation Reactions

-Solubility and solubility product of sparingly soluble salts.
- Factors influencing solubility of sparingly soluble salts.

4. Complexes in solution

- Concept of complexes
- Stability and dissociation of complexes

5 Oxidation-reduction reactions

- Definitions
- Writing oxidation-reduction reactions

Chapter II : Conductimetry (3 weeks)

-Background on electrolytic solutions
-Arrhenius Theory on electrolytes dissociation
- Oswald dilution law
-Conductivity of ions- ions mobility – Kohlrausch law, transport number.

Chapter III : Electrochemical thermodynamics and galvanic cell (4 weeks)

- Nernst Formula - redox standard potential

- Prediction of the direction of the oxidation-reduction reactions
-Electrode potentials and the effects of complexes, pH et solubility product
-Concept of galvanic cell – cell potential- applications

Chapter IV : Electrolysis and Faraday law (3 weeks)

- Electrolysis and electrolysers -Faraday law- Current efficiency- Electrical energy consumption

Laboratory work

Laboratory work 1 : Conductimetry and conductimetric titration
Laboratory work 2 : Constructing voltaic cell
Laboratory work 3 : Concentration voltaic cell
Laboratory work 4 : Potentiometric titration
Laboratory work 5: Electrolysis - Electrodeposition and electrowinning of copper.

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

1. Genévrière ML Dumas, Roger Benaîm, l'indispensable en électrochimie, Breal, 2001.
2. P.W. Atkins & Julio de Paula.The Elements of Physical Chemistry, , 8th edition, Oxford University Press, Oxford 2006.
3. G. Milazo, Electrochimie », Dunod,1969.
4. Brenet, Introduction à l'électrochimie de l'équilibre et du non équilibre, Masson,1980.
5. Allen J. Bard, Electrochimie : principes, méthodes et applications », Masson, 1983.
6. Fabien Miomandre, SaïdSadki, Pierre Audebert, Electrochimie des concepts aux applications, Dunod, 2005.
7. F. Cœuret, A. Stock,Eléments de génie électrochimique , Lavoisier Tech. &.Doc, 1993.
8. **Élisabeth Bardez** , Chimie générale, Dunod, Paris, 2009
9. Darrell D. Ebbing, Steven D. Gammon, General chemistry, 9th edition, 2009, Houghton Mifflin
Company, 222 Berkeley Street, Boston, MA 02116-3764.

Teaching Unit	Subject Title	Code	Semester
UEF 2.1.3	Mechanics of Rigid Bodies 1	MRBB1	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H00	3

Objective

The objective of this course is to provide students with a fundamental understanding of the mechanics of rigid bodies in static and dynamic conditions. Students will develop the ability to:

- Analyze the equilibrium of rigid bodies using force and moment balance.
- Construct and interpret free-body diagrams (FBDs) for various force systems.
- Understand different types of forces, including frictional and distributed forces.
- Describe the motion of rigid bodies in both planar and spatial contexts using kinematic principles.
- Calculate mass properties such as the center of mass and moments of inertia.
- Apply theoretical concepts to solve real-world engineering problems involving rigid body mechanics.

Prerequisites

- **Mathematics:** Calculus (differentiation and integration), Linear Algebra
- **Physics:** Newtonian Mechanics (basic force and motion concepts)
- **Engineering Fundamentals:** Basic knowledge of statics and vector analysis

Content

Chapter 1: Statics of Rigid Bodies

- Equilibrium of forces and moments
- Free-body diagrams (FBD)
- Types of forces: concentrated, distributed, frictional
- Moment of a force and torque
- Conditions for static equilibrium
- Applications

Chapter 2: Kinematics of Rigid Bodies

- Motion of a rigid body in a plane and space
- Velocity and acceleration in rigid body motion
- Rotational motion (angular velocity, angular acceleration)
- Instantaneous center of rotation
- Relative motion analysis

Chapter 3: Distribution of Mass in a Rigid Body

- Center of mass and centroid
- Mass moment of inertia
- Radius of gyration
- Parallel axis and perpendicular axis theorems
- Calculation of moments of inertia for common shapes
- Applications

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

1) Ferdinand P. Beer et al. “Vector Mechanics For Engineers. Statics and Dynamics”. Eleventh
edition. Published by McGraw-Hill Education, 2016
2) Edward Diehl. “The Engineering Dynamics Course Companion, Part 2: Rigid Bodies Kinematics and Kinetics”. Morgan &cLaypool publishers 2021
3) “Introduction to STATICS and DYNAMICS”. Rudra Pratap and Andy Ruina Spring 2001

Teaching Unit	Subject Title	Code	Semester
UEF 2.1.3	General Electricity	ELT	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	4

Objective

This module introduces students to the **fundamentals of alternating current (AC) electricity**, focusing on single-phase and three-phase systems, power analysis, and general theorems in electrical circuits. Students will:

1. Understand **Kirchhoff's laws** in sinusoidal steady-state circuits and learn their application using **complex notation**.
2. Analyze and compute **single-phase and three-phase power**.
3. Explore key theorems of electric circuits for solving and simplifying complex electrical networks.

.

Prerequisites

- Basic knowledge of mathematics, especially complex numbers and trigonometry.
- Introduction to physics, particularly electromagnetism and electrical circuits.

Content

CHAPTER 1: Kirchhoff's Laws in Sinusoidal Regime (3 weeks)

- Basic notions of alternating current (AC): Voltage, current, and frequency in single-phase systems.
- Kirchhoff’s voltage and current laws (KVL and KCL) applied to AC systems.
- Simplification of Kirchhoff's laws using complex representation (phasors).
- Concept of impedance (resistive, inductive, capacitive elements).
- Voltage and current dividers: Understanding and applying divider rules in AC circuits.
- Equivalence between current and voltage sources: Thévenin and Norton equivalence in steady-state.
- Independent and dependent sources: Definition and examples in electrical circuits..

CHAPTER 2: Single-Phase Electric Power (2.5 weeks)

- Active, reactive, and apparent power.
- Power factor and its significance in AC circuits.
- Power measurement techniques in single-phase circuits.

CHAPTER3: Three-Phase Sinusoidal Regime (2.5 weeks)

- Structure and configurations of three-phase systems (star and delta).
- Voltage and current relationships in balanced and unbalanced systems.
- Phasor diagrams for three-phase systems..
- Applications

CHAPTER4: Three-Phase Power (2 weeks)

- Analysis of active, reactive, and apparent power in three-phase systems.
- Power measurement in three-phase systems using the two-wattmeter method.
- Practical applications of three-phase systems in industrial and domestic settings..

CHAPTER5: General Theorems of Electric Circuits (5 weeks)

- Superposition theorem: Solving circuits with multiple independent sources.
- Thévenin and Norton theorems: Simplifying complex circuits.

- Maximum power transfer theorem: Application and conditions for maximum power delivery.
- Equivalence of generators: Understanding and applying equivalence in circuit analysis.
- Kennelly's theorem: Star-delta (or delta-star) transformations.
- Millman's theorem: Simplification of circuits with parallel branches.
- Independent mesh method: Analyzing complex circuits by calculating mesh currents.
- Node voltage method: Efficiently solving circuits using nodal analysis.

Laboratory work

- **Lab 1:** Introduction to AC Circuits.
- **Lab 2:** Voltage and Current Dividers.
- **Lab 3:** Impedance in AC Circuits.
- **Lab 4:** Single-Phase Power Measurement.
- **Lab 5:** Three-Phase Systems.
- **Lab 6:** Circuit Theorems in AC Systems.

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

- Textbook: "Fundamentals of Electric Circuits" by Charles K. Alexander and Matthew N. O. Sadiku.
- Practical Guide: "Electrical Engineering Fundamentals" by Giorgio Rizzoni.
- Additional Materials: Manufacturer datasheets for AC components, simulation tools (e.g., LTSpice, Multisim).

Teaching Unit	Subject Title	Code	Semester
UEF 2.1.3	Fluid Mechanics	FLM	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	3

Objective

- Fournir des connaissances de base de la statique des fluides
- Apprendre à décrire un fluide en mouvement à l'aide de champs
- Mettre en place les théorèmes de la mécanique des fluides
- Fournir les éléments de base nécessaires à la résolution des problèmes d'écoulement de fluides parfaits et reels

Prerequisites

- Mécanique du point matériel
- Statique d'un corps solide
- Thermodynamique
- Analyse mathématique

Content

Chapter 1: INTRODUCTION TO FLUID MECHANICS

1. Introduction
2. Definition of a Fluid
3. Different Types of Fluids (Perfect Fluid , Real Fluid , Incompressible fluid, Compressible fluid)
4. Physical Properties of Fluids (Density, Specific Weight, Relative density, Viscosity, Surface Tension, Capillarity , Vapor pressure, Compressibility, Expansion)
5. Properties of Gases

Chapter 2: Fluid statics (hydrostatic)

1-Introduction
2-Notion of pressure
3-Fundamental Equation of Hydrostatics
4-The Transmission of Pressures (Pascal's Principle)
5-Archimedes' Buoyancy
6-Pressure Measuring Devices
7- Pressure Forces Acting on Submerged Walls

Chapter 3: Perfect incompressible fluid dynamics

1. Introduction
2. **Context (Velocity,** Velocity Field, Acceleration)
3. Différents flow regimes
4. Eulérienne Lagrangian and Eulerian Descriptions
5. Streamline, Stream tube and pathline
6. Flow rate concept
7. Continuity Equation
8. Energy Conservation for an Ideal Fluid: Bernoulli's Theorem
9. Applications of Bernoulli's theorem
10. Euler's Theorem

Chapter 4: Dynamics of Real Incompressible Fluids

1. Introduction
2. Flow Regimes - Reynolds Number
3. Concept of Head Losses
4. Bernoulli's Theorem Applied to a Real Fluid with Work Exchange

Laboratory work

Hydrostatique

- Poussée hydrostatique

Hydrodynamique

- Déversoirs
- Venturi

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

[1] Mécanique des fluides 2e année PC-PC*/PSI-PSI* J.M. BREBEC – Ed HACHETTE
[2] Physique théorique : Mécanique des fluides LANDAU et LIFCHITZ – Ed ELLIPSES
[3] Mécanique des fluides 2e année PC, PSI : Problèmes corrigés LUMBROSO– Ed DUNOD
[4] Mécanique des fluides appliquée OUZIAUX – Ed DUNOD
[5] Mécanique des fluides et hydraulique : cours et problèmes, RANALD– Ed SCHAUM
Mécanique des fluides Puissance prépas, PC-PSI A. HEINRICH – Ed BREAL

Teaching Unit	Subject Title	Code	Semester
UEF 2.1.3	Advanced Data Structures and Algorithms	ADS	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	01H00	3

Objective

Understand and analyze algorithmic complexity to evaluate efficiency.
Manipulate dynamic data structures: stacks, queues, trees, and graphs.
Design and implement recursive algorithms and compare them with iterative approaches.
Apply data structures to real-world programming problems using C++

Prerequisites

Introduction to Programming.
Programming and Data Structures.

Content

Chapter 1: Algorithm Complexity (Course: 03h00)

- Time and space efficiency.
- Landau notation
- Complexity analysis of iterative algorithms.

Chapter 2: Advanced Linear Data Structures (Course: 04h30)

- **Stacks**: principles, implementation, applications.
- **Queues**: FIFO, circular queues, priority queues.

Chapter 3: Recursive Programming & Complexity (Course: 06h00)

- Definition and principles of recursion.
- Recursion vs iteration (stack usage, memory impact).
- Applications: recursive sorting (MergeSort, QuickSort), tree traversal, Fibonacci sequence.
- Complexity analysis of recursive algorithms

Chapter 4: Hierarchical Data Structures Trees (Course: 06h00)

- Definition and basic functions.
- Binary trees: definition, traversal methods (preorder, inorder, postorder).
- Binary Search Trees (BSTs): insertion, deletion, balancing (AVL).
- m-ary trees: definition, transformation into binary trees.

Chapter 5: Graph Data Structures (Course: 03h00)

- **Graph representation**: adjacency matrices, adjacency lists.
- **Graph traversal**: Depth-First Search (DFS) and Breadth-First Search (BFS).
- **Applications**: shortest path algorithms (Dijkstra, Floyd-Warshall).

Laboratory work

PW1: Algorithm complexity.
PW2: Implementing stacks and queues
PW3: Recursive programming
PW4: Manipulating binary trees and optimized searching.
PW5: Implementing graphs.

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

Cormen, T. H., Leiserson, C. E., Rivest, R. L., Stein, C. Introduction to Algorithms. MIT Press.
Sedgewick, R. Algorithms in C. Addison-Wesley.
Weiss, M. A. Data Structures and Algorithm Analysis in C. Pearson.

Teaching Unit	Subject Title	Code	Semester
UEM 2.1.1	Digital Logic and Combinational Circuitsls	DLCC	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H30	3

Objective

This course provides a solid foundation in digital logic, focusing on **number systems, Boolean algebra, combinational and introduction to Sequential circuits**.

Prerequisites

Basic mathematical logic and problem-solving

Content

1. Introduction to Digital Systems (1 weeks)

- Difference between Analog and Digital Systems
- Real-world applications of digital systems (computers, embedded systems, communication)

2. Number Systems and Coding (2 weeks)

- Number Systems: Binary, Octal, Hexadecimal, Decimal
- Conversions between number systems
- Digital Encoding: ASCII, Gray Code, BCD, Hamming Code

3. Boolean Algebra and Logic Simplification (3 wwka)

- Basic Boolean operations and laws
- Truth tables and logical expressions
- Simplification techniques: Karnaugh Maps (K-Maps)

4. Logic Gates and Combinational Circuits (3 weeks)

- Basic Logic Gates: AND, OR, NOT, XOR, NAND, NOR
- Combinational Components: Adders, Multiplexers, Decoders
- How to design a basic digital circuit from scratch

5. Introduction to Sequential Circuits (3 weeks)

- What are sequential circuits? (Difference between combinational and sequential circuits)
- Flip-Flops (FFs): D, JK, T
- Applications of flip-flops in storage circuits.

Laboratory work

- **Lab 1:** Discovering and simulating logic gates
- **Lab 2:** Designing and optimizing combinational circuits
- **Lab 3:** Building and testing a binary adder and multiplexer, ect,
- **Lab 4:** Understanding and experimenting with flip-flops

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).

- Final exam (60%).

References

1.Digital Logic and Computer Design" – M. Morris Mano
2.Digital Design: Principles and Practices" – John F. Wakerly
3.Digital Electronics: Principles, Devices and Applications" – Anil K. Maini
4.Digital Systems: Principles and Applications" – Ronald J. Tocci
5. Boolean Algebra and Its Applications" – J. Eldon Whitesitt

Teaching Unit	Subject Title	Code	Semester
UET2.1.1	Entrepreneurship	ENT	3

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	00H00	00H00	1

Objective

Prerequisites

Content

Assessment Methods:

- Final exam (100%).

References

Semester 4

Teaching Unit	Subject Title	Code	Semester
UEF 2.2.1	Analysis 4	ANA 4	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H00	3

Objective

Have the basic knowledge about Power series, Fourier series, Fourier transformation and Preliminaries on partial differential equations.

Prerequisites

Analysis 1 & 2 & 3.

Content

Chapter 1 : Power series

Definition and operations on power series, radius and interval of convergence, properties of the sum. Taylor series and Maclaurin series of smooth functions

Chapter 2 : Fourier series

Trigonometric series (definition and properties of the sum, convergence)

Fourier series (Fourier series of a periodic integrable function, Dirichlet's theorem, Parseval identity)

Chapter 3 : Fourier transform (TF for short)

Introduction (Fourier integral, its properties and its complex form, definion of TF, reverse TF, the derivative of a TF, TF of a derivative)

Operations on TF (linearity, TF of translation, Tf of homothety, convulsion product, Parseval identity)

Sinus and cosinus-TF

Chapter 4 : Partial differential equations (PDE for short)

Generalities on PDEs (definition, order, linear PDEs, homogeneous PDEs)

Classification of linear PDEs of order two with constant coefficients (Parabolic PDEs, Hyperbolic PDEs, Elliptic PDEs)

Examples (wave equation, heat equation, Laplace equation)

Resolution of certain PDEs (Change of variables, separation of variables, by the Fourier transform)

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

1- J. Lelong-Ferrand, J.M. Arnaudiès, Cours de Mathématiques - Equations différentielles, Intégrales multiples, Tome 4, Dunod Université.

2- N. Piskounov, Calcul différentiel et intégral, Tome 1, Edition de Moscou

3- James Stewart, Calculus, Cengage learning

4- François LIRET ; mathématiques en pratique, cours et exercices; DUNOD. (f.p.v ; Int. Mult. Séries…)

5- Mathématiques exercices résolus, office des publications universitaires. (Transformées de Fourier et de Laplace).

6- A. MONSOURI, M.K. BELBARKI. Elément d'analyse. Cours et exercices résolus. 1er cycle universitaire. CHIHEB. (Intégrales doubles et triples, Séries, Transformations de Fourier et de Laplace, Equations aux dérivées partielles du 2iéme ordre).

Teaching Unit	Subject Title	Code	Semester
UEF 2.2.2	Numerical Analysis 2	NUM2	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H30	3

Objective

The course presents numerical methods for the solution of mathematical problems such as non-linear equations and systems of linear equations, functions approximation, integration and differentiation, and differential equations.

Prerequisites

Numerical Analysis 1

Content

Chapter 4: Numerical Differentiation and Integration (7.5 hours)

1. Numerical Integration:
   - Trapezoidal Method, Gregory's Formula.
   - Simpson's Method.
   - Newton-Cotes Formula.
2. Gaussian Integration.
3. Numerical Differentiation and Error Estimation.

Chapter 5: Numerical Solution of Differential Equation (6 hours).

1. Introduction to Differential Equations.
2. Euler's Method.
3. Runge-Kutta Method.
4. Finite-Difference Method.

Chapter 6: Direct Methods for Solving Linear Systems (6 hours)

1. Triangular Linear Systems.
2. Gaussian Elimination and Matrix Factorization.
3. Pivoting Strategies.
4. Triangular Factorization: LU and PLU Factorizations.
5. Cholesky Decomposition.

Chapter 7: Iterative Methods for Solving Linear Systems (6 hours)

1. Vectors and Matrix Norms.
2. Convergence and Perturbation Theorems.
3. Jacobi Iterative Method.
4. Gauss-Seidel Method.
5. Relaxation in Gauss Method.

Laboratory work

1. **Solutions of Nonlinear Equations in One Variable**
   - 1.1. Bissection Method.
   - 1.2. Fixed Point Method.
   - 1.3. Newton-Raphson Method.
2. **Interpolation and Approximation**
   - 2.1. Newton Interpolation.
   - 2.2. Tchebychev Approximation.
3. **Numerical Integration**

3.1. Trapezoidal Method.
3.2. Rectangle Method.
3.3. Simpson Method.

4. **Differential Equations**
   4.1. Euler Method.
   4.2. Runge-Kutta Method.

5. **Linear Systems of Equations**
   5.1. Gauss- Jordon Method.
   5.2. Triangularization: LU, PLU.
   5.3. Jacobi Method.
   5.4. Gauss-Seidel Method.

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

1. A. Burden, R. L. Burden, J. D. Faires, Numerical Methods, Brooks/Cole Publishing Company, (10th Edition 2016).
2. S. D. Cone, C. de Boor, Elementary Numerical Analysis, McGraw-Hill Book Company, (3rd Edition 1981).
3. D. Kincaid, W. Cheney, Numerical Analysis and Mathematics for Scientific Computing, Brooks/Cole Publishing Company, (1991).
4. G. M. M. Phillips, P. J. Taylor, Theory and Applications of Numerical Analysis, Elsevier Science & Technology Books, (2nd Edition 1996).
5. M. Schatzman, Numerical Analysis, Clarendon Press, Oxford, (2002).
6. L. F. Shampine, R. C. Allen, Jr & S. Pruess, Fundamentals o Numerical Computing, Wiley & Sons, (1st 1997).
7. J. Stoer, R. Bulirsch, Introduction to Numerical Analysis, Springer-Verlag, (3rd Edition 2002).

Teaching Unit	Subject Title	Code	Semester
UEF 2.2.2	Physics 4	PHY4	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H30	4

Objective

- Understand the fundamental properties of waves (period, frequency, velocity).
- Differentiate between transverse and longitudinal waves.
- Study reflection, transmission, impedance, and the Doppler effect.
- Apply these concepts to sound waves, electromagnetic waves, and telecommunications.

Prerequisites

- **Differential and integral calculus**: gradients, divergence, curl, multiple integrals.
- **Harmonic oscillator**: free, damped, forced, resonance.
- **Continuum mechanics**: wave propagation, wave velocity, impedance.

Content

Chapter 1: General Concepts of Waves (2 weeks)

- General Definitions:
  - Waves, temporal period - spatial period; wave vector, phase velocity, propagation forms.
- Types of Waves:
  - Plane progressive wave in the sinusoidal regime.
  - Plane reflected wave in the sinusoidal regime.
  - Standing waves.
- Propagation Media:
  - Non-dispersive media.
  - Dispersive media.
- Spherical Waves.
- Classical Doppler Effect.

Chapter 2: Vibrating String (4 weeks)

- Wave propagation equation for a free string - Wave velocity.
- Sinusoidal plane progressive wave.
- Application of a standing wave - Stretched string.
- Concept of mechanical impedance.
- Reflection and transmission between two different media - Continuity conditions.
- Analogy with electrical transmission lines.

Chapter 3: Elastic Waves in Fluids (3 weeks)

- Definitions and Properties.
- Wave Equation.
- Mathematical Solutions.
- Concept of Acoustic Impedance.
- Energy Transport in Fluids.
- Reflection and Transmission Coefficients.
- Standing Waves - Resonance Concept.
- Sound Intensity - Decibel Level.

Chapter 4: Waves in Solids (2 weeks)

- Definitions and Properties: Hooke’s Law.

- Propagation equation of elastic waves - Wave velocity.
- Sinusoidal progressive longitudinal wave.
- Total Energy Density.

Chapter 5: Electromagnetic Waves (4 weeks)

- Definitions.
- Review of Maxwell's Equations.
- Electromagnetic Waves in Vacuum - Properties.
- Polarization.
- Energy Density - Poynting Vector.
- Propagation in Conductors.
- Propagation in Perfect Dielectrics.

Laboratory work

- String vibrations.
- Dependence of sound velocity in liquids on temperature.
- Light polarization.
- Wave study using a ripple tank.
- Light diffraction.

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

- H. Djelouah; Electromagnetism; Office des Publications Universitaires, 2011.
- Waves, Jean-Claude Hulot, Nathan Editions.
- Physics Course: Electromagnetism, D. Cordier, DUNOD Editions.

Teaching Unit	Subject Title	Code	Semester
UEF 2.2.2	Chemistry 4	CHM4	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H30	3

Objective

The aim of this matter is to :

-Acquire skills in electrochemical kinetics necessary to the comprehension of the phenomena and applications of electrochemistry.

-Acquire theoretical and practical knowledge on energy storage and conversion using electrochemistry

-Acquire knowledge on the principles of electrochemical sensors and their applications in autonomous systems.

Prerequisites

Inorganic chemistry, solution chemistry, basics in electrochemistry, chemical thermodynamics, concepts in electricity

Content

Chapter I : Electrochemical kinetics (4 weeks)

-Electrochemical reaction rate- polarization and overpotential

- Electrochemical Instrumentation : Potentiostat/Galvanostat et three electrodes setup

-Polarization curves

-Charge transfer and mass transport (Butler-Vollmer law, Tafel law and Fick law).

- Electrical double layer

Chapter II: Electrochemical methods and techniques (3 weeks)

Amprrometry, potentiometry, Voltamperometry, Chronopotentiometry, cyclic voltametry, impedance spectroscopy

Chapter III : Electrochemical systems for energy storage and conversion (5weeks)

-Batteries: Galvanic cell and electric accumulator, Different types of batteries, energetic efficiency

-Electrolytic production of hydrogen

-Fuel cells: Principle, different types of fuel cells,

-Design and operating of fuel cells for autonomous systems

Chapiter IV : Electrochemical sensors (3weeks)

-Definitions and principles

-Types of electrochemical sensors: amperometric, conducimetric, potentiometric

-Applications in drones

Laboratory work

Laboratory work 1 : Plotting polarization curves

Laboratory work 2 : Potentiometric titration-Checking Nernst formula

Laboratory work 3: Characterization of a battery

Laboratory work 4: Construction of a fuel cell

Laboratory work 5: Electrolytic hydrogen production

Laboratory work 6: Construction of an electrochemical sensor via 3D printing

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

1. G. Milazo, « Electrochimie », Dunod,1969.
2. Brenet, « Introduction à l'électrochimie de l'équilibre et du non équilibre », Masson,1980.
3. Allen J. Bard, « Electrochimie : principes, méthodes et applications », Masson, 1983.
4. F.Cœuret, A. Stock,« Eléments de génie électrochimique », Lavoisier Tech. &.Doc, 1993.
5. Robert A. Huggins, Advanced Batteries Materials Science Aspects Springer Science+Business Media, 2009, Springer Science Business Media, LLC, 233 Spring Street, New York, NY 10013, USA
6.Dhameja, Sandeep electric vehicle battery systems 2002, Butterworth–Heinemann225 Wildwood Avenue Woburn, MA 01801-2041, UK
7. B Scrosati, C A Vincent, Modern batteries, 1997 Second Edition , Butterworth-Heinemann Linacre House, Jordan Hill, Oxford OX2 8DP 200 Wheeler Road, Burlington, MA 01803
8. DAVID A. J. RAND, RONALD M. DELL, Understanding batteries, 2001, The Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 OWF, UK,
9.Ram B. Gupta, Hydrogen fuel Production, Transport and Storage, 2009, CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742
10.Hubert H. Girault, Marcel Dekker, Analytical and physical electrochemistry, 2004, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A.,
11. Joseph Wang, Analytical electrochemistry, Third Edition 2006, Published by John Wiley & Sons, Inc., Hoboken, New Jersey
12.Xueji Zhang, Huangxian Ju, Joseph Wang, 2008, Electrochemical Sensors, Biosensors and Their Biomedical Applications, World Precision Instruments, Inc., Sarasota, Florida, USA

Teaching Unit	Subject Title	Code	Semester
UEF 2.2.3	Mechanics of Rigid Bodies 2	MRB2	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H00	3

Objective

This course aims to develop a deep understanding of the dynamics of rigid bodies, emphasizing force, motion, energy, and stability. Students will learn to:

- Formulate and apply Newton's Second Law to analyze the motion of rigid bodies.
- Derive and solve equations of motion for translational and rotational systems.
- Utilize work-energy and impulse-momentum principles to solve engineering problems.
- Understand and apply the conservation of angular momentum.
- Analyze stability and equilibrium of mechanical systems using the principle of virtual work.
- Introduce advanced analytical mechanics, including Lagrangian and Hamiltonian mechanics, for a more generalized approach to motion analysis.
- Explore applications such as rolling motion, gyroscopic effects, and planetary motion.

Prerequisites

- **Mathematics:** Calculus (differentiation, integration), Linear Algebra, Differential Equations
- **Physics:** Newtonian Mechanics, Energy and Momentum Conservation
- **Engineering Fundamentals:** Statics, Kinematics of Rigid Bodies, Basic Knowledge of Work-Energy Principles

Content

Chapter 4: Kinetics of Rigid Bodies (Including Momentum & Angular Momentum)

- Newton's Second Law for rigid bodies
- Equations of motion (translational and rotational)
- Work and energy principles for rigid bodies
- Impulse and momentum principles
- Angular momentum and its conservation
- Applications: Rolling motion, gyroscopes, rotating mechanisms

Chapter 5: Virtual Work & Stability

- Principle of virtual work for rigid bodies
- Applications to equilibrium of mechanical systems
- Stability of equilibrium
- Small oscillations and vibrations

Chapter 6: Lagrangian Mechanics & Advanced Topics

- Generalized coordinates and degrees of freedom
- Constraints and classification
- Lagrange's equations of motion for rigid bodies
- Hamiltonian mechanics (optional)
- Central force motion (Kepler's laws, planetary motion)

Assessment Methods:

- Regular in class assessments (40%).
- Final exam (60%).

References

- Ferdinand P. Beer et al. “Vector Mechanics For Engineers. Statics and Dynamics”. Eleventh
  edition. Published by McGraw-Hill Education, 2016
- Edward Diehl. “The Engineering Dynamics Course Companion, Part 2: Rigid Bodies Kinematics and Kinetics”. Morgan &cLaypool publishers 2021
- “Introduction to STATICS and DYNAMICS”. Rudra Pratap and Andy Ruina Spring 2001

Teaching Unit	Subject Title	Code	Semestre
UEF 2.2.3	General electronics	ELN	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	4

Objective

This module provides students with a solid foundation in electronics, covering quadripoles, passive filters, diodes, and bipolar transistors. Students will:

1. Understand and analyze quadripoles using various matrix representations and evaluate their characteristics.
2. Explore the design and analysis of passive filters and their frequency responses.
3. Gain insights into the operation and applications of diodes, including rectification and stabilization.
4. Study the bipolar transistor as a key component in amplification and switching circuits.

Prerequisites

- Basic knowledge of mathematics (matrices, logarithms) and physics (electricity and semiconductors).
- Understanding of fundamental circuit laws (Ohm's law, Kirchhoff's laws).

Content

CHAPTER 1: Quadripoles (3.5 weeks)

5. Introduction: Definition and applications of quadripoles in circuit analysis.
6. Matrix Representations: Z (impedance), Y (admittance), H (hybrid), T (transmission), G (inverse hybrid), and A (scattering) parameters.
7. Quadripole Associations: Series, parallel, and cascade associations.
8. Relations Between Matrix Parameters: Conversion formulas between different matrix representations.
9. Characteristics of Loaded Quadripoles: Input and output impedances, Voltage and current gains. Characteristic impedance.

CHAPTER 2: Passive Filters **(3 weeks)**

- Introduction: Overview of filters and their importance in signal processing.
- Ideal and Real Filters: Types (low-pass, high-pass, band-pass, and band-stop).
- Transfer Function: Analysis and derivation.
- Bode Diagrams: Construction and interpretation , Advantages of using decibels (dB) in frequency response analysis.

CHAPTER3: Junction Diode (3.5 weeks)

- Introduction and Principle of Operation: Structure and behavior of PN junction diodes.
- Rectification, Filtering, and Stabilization:
  - Half-wave and full-wave rectifiers.
  - Filtering techniques (capacitive and inductive filters).
  - Voltage regulation and stabilization.
- Specific Diodes: Zener diodes, Schottky diodes, LED, and photodiodes

CHAPTER4: Bipolar Junction Transistor (5 weeks)

- Introduction and Structure: NPN and PNP transistors.
- Operating Modes: Cutoff, active, and saturation.
- Transistor as an Amplifier:

    - Small-signal analysis.
    - Common-emitter, common-collector, and common-base configurations.
- Switching Applications: Transistor as a digital switch.

Laboratory work

- **Lab 1:** Introduction to Quadripoles.
- **Lab 2:** Passive Filters.
- **Lab 3:** Diode Circuits.
- **Lab 4:** Bipolar Junction Transistor.

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

- Textbook: “Electronic Devices and Circuit Theory” by Robert L. Boylestad and Louis Nashelsky.
- Practical Guide: “Fundamentals of Electronics” by Thomas L. Floyd.
- Additional Materials: Circuit simulation tools (e.g., Multisim, LTSpice).

Teaching Unit	Subject Title	Code	Semester
UEF 2.2.3	Strength of Materials	MOM	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H30	3

Objective

- Introduction to the fundamental concepts of Strength of Materials
- Study of the influence of geometric shape choices in Strength of Materials
- Study of different types of loadings
- Introduction to beam theory and basic analysis of isostatic systems

Prerequisites:

- Mathematics (Integral and Differential Calculus)
- Mechanics (Laws of Statics)

Content

Chapter 1 : INTRODUCTIONS AND GENERALITIES (04 weeks)

1.1 Goals and Assumptions of the Strength of Materials
1.2 Classification of Solids (Beam, Plate, Shell)
1.3 Different Types of Loads
1.4 Static Review – Equilibrium Equations
1.5 Method of Sections (Cuts) – Internal Forces and Moments
1.6 Definitions and Sign Conventions for internal Forces and Moments
1.7 Concept of Stress and Strain.

Chapter 2 : GEOMETRIC CHARACTERISTICS OF PLANE AREAS (03 weeks)

2.1 First Moment and Centroids
2.2 Axial and polar Moments and Product of Inertia
2.3 Parallel-Axis Theorem for Moments of Inertia
4.4 Rotation of Axes, Principal axes and Principal moments of Inertia

Chapter 3 : AXIAL LOADING (03 weeks)

3.1 Definitions
3.2 Normal Stress in Tension and Compression
3.3 Elastic Deformation in Tension/Compression
3.4 Strength and rigidity criteria

Chapter 4: TORSION (02 weeks)

4.1 Definitions
4.2 Shear stress
4.3 Shearing Strains in torsion
4.4 Strength and rigidity criteria

Chapter 5 : PURE BENDING AND NONUNIFORM BENDING (03 weeks)

5.1 Definitions and Assumptions
5.2 Shear Forces and Bending Moments
5.3 Shear Forces and Bending Moments Diagrams
5.4 Relationships between loads, shear forces and bending moments
5.5 Deflection of Beams
5.6 Design of Beams for Bending

Laboratory work

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

1- Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek - Mechanics of Materials, 8th Edition (2020, McGraw-Hill).
2- Barry J. Goodno, James M. Gere - Mechanics of Materials (2018, Cengage Learning).
3- Russell C. Hibbeler - Mechanics of Materials in SI Units-Pearson (2017).
4- Kiusalaas, Jaan_Pytel, Andrew_Sharma, Ishan - Mechanics of materials-Cengage Learning (2012).
5- R. C. Hibbeler - Statics and mechanics of materials (global Ed.)-Pearson _ Prentice Hall (2019).

Teaching Unit	Subject Title	Code	Semestre
UEM2.2.1	Object Oriented Programming	OOP	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	00H50	3

Objective

The objective of this course is to teach the basic concepts of Object-Oriented Programming (OOP) through practice using the C++ language. Each chapter contains theoretical frameworks that are translated to suit each subject so that the student can translate the acquired theoretical concepts into practice. At the end of the semester, the student is expected to have acquired the following skills:

1- The essence of object-oriented programming and its transformation into C++ language

2- Acquire intuitive reasoning to provide a solution to a simple problem according to the object-oriented approach

3- The essence and importance of OO reasoning and OOP

Prerequisites

- The C language.
- A good foundation in programming.

Content

Chapter 1. Introduction to Object-Oriented Programming (OOP) **(03h00)**

1. Principle of OOP.
2. Definition and Getting Started with the C++ as an Object-Oriented Language.
3. The C Core of the C++ Language.

Chapter 2. Classes and objects **(06h00)**

1. Class declaration.
2. Instance variables and methods.
3. Method definition.
4. Access rights and encapsulation.
5. Prototype and definition separation.
6. Constructor and destructor.
7. Constant methods.
8. Association of classes between them.
9. Classes and pointers

Chapter 3. Inheritance and Polymorphism **(04h30)**

1. Inheritance.
2. Inheritance Rules.
3. Constructor Chaining.
4. Preprocessor and Compiler Directives.
5. Polymorphism.
6. Abstract Methods and Classes.
7. Interfaces.
8. Method Chaining.
9. Implementing Virtual Methods.
10. Nested Classes.

Chapter 4. Containers, Iterators and Functors **(04h30)**

1. Sequences and their adapters.
2. Associative tables.
3. Choosing the right container.
    a) Iterators: boosted pointers.
4. The full power of lists and maps.
5. Functor:
    a) The object version of functions.
    b) Fusion of the two concepts.

Chapter 5. Advanced concepts **(04h30)**

1. Exception handling.
2. The standard exception.
3. Assertions.
4. Template functions.
5. Specialization.
6. Template classes.

Laboratory work

TP1: Mastering a C++ compiler **(01h30)**
TP2: C++ programming **(03h00)**
TP3: Classes and objects **(06h00)**
TP4: Inheritance and polymorphism **(06h00)**
TP5: Interfaces **(03h00)**
TP6: Templates **(03h00)**

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

1. **Stroustrup, B.**Programming: Principles and Practice Using C++ (2e éd.). Addison-Wesley.(2014)
2. **Lippman, S. B., Lajoie, J., & Moo, B. E.**C++ Primer (5e éd.). Addison-Wesley. (2012)
3. **Meyers, S.** (2005). Effective C++: 55 Specific Ways to Improve Your Programs and Designs (3e éd.). Addison-Wesley.(2005) .
4. **Stroustrup, B.** . The C++ Programming Language (4e éd.). Addison-Wesley.(2013)
5. **Josuttis, N. M.**C++ Standard Library: A Tutorial and Reference (2e éd.). Addison-Wesley.(2012).

Teaching Unit	Subject Title	Code	Semester
UED 2.2.1	Digital Systems and Sequential Circuits	ING2	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	01H30	01H00	3

Objective

This course builds on sequential logic with an emphasis on registers, counters, graphical methods, and digital memory systems.

Prerequisites

Digital Logic Fundamentals

Content

1. Counters and Registers (3 weeks)
   - Introduction to Advanced Sequential Circuits
   - Types of Counters: Asynchronous, Synchronous, Johnson, Ring
   - Shift Registers and Applications
   - Applications of Registers in Data Conversion

2. Graphical Methods and Finite-State Machines (FSMs) (3 weeks)
   - State tables and state diagrams
   - Moore and Mealy machines
   - State minimization and optimization techniques

3. Digital Memory Systems (3 weeks)
   - Types of Memory: RAM, ROM, EPROM, EEPROM
   - Memory organization and addressing
   - Comparison between static and dynamic memory

4. Circuit Optimization and Digital System Implementation (3 weeks)
   - State minimization techniques
   - Computer-aided design methods
   - Applications of optimized sequential circuits

Laboratory work

Lab 1: Design and implementation of counters and registers
Lab 2: Design and simplification of Moore and Mealy machines
Lab 3: Experimentation with digital memory systems (EEPROM, RAM, etc.)
Lab 4: Design and implementation of an Arithmetic and Logic Unit (ALU)

Assessment Methods:

- Regular in class assessments (20%).
- Laboratory reports and practical assignments (20%).
- Final exam (60%).

References

1. Digital Logic and Computer Design – **M. Morris Mano**
2. Digital Design: Principles and Practices – **John F. Wakerly**
3. Digital Electronics: Principles, Devices and Applications– **Anil K. Maini**
4. Digital Systems: Principles and Applications – **Ronald J. Tocci**

5. Introduction to Logic Design" – **Alan B. Marcovitz**
t

Teaching Unit	Subject Title	Code	Semester
UET2.2.1	Ethics and deontology	ETD	4

	Course	Tutorial	LW	Credit/ Coeff
Weekly time	01H30	00H00	00H00	1

Objective

Prerequisites

Content

Assessment Methods:

- Final exam (100%).

References