# ACADEMIC MASTER HARMONIZED

# National Program

# Updated 2022

| Domain | Field | Speciality |
|---|---|---|
| ***Science and Technology*** | ***Métallurgy*** | ***Metallurgical Engineering*** |

الجمهورية الجزائرية الديمقراطية الشعبية République Algérienne Démocratique et Populaire
وزارة التعليم العالي والبحث العلمي
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique
Comité Pédagogique National du domaine Sciences et Technologies

# مواءمة

# ماستر أكاديمي

# تحيين 2022

| الميدان | الفرع | التخصص |
|---|---|---|
| علوم وتكنولوجيا | تعدين | هندسة التعدين |

# I – Master Identification Form

## Access Conditions

| Field : | Harmonized Master | Undergraduate degrees granting access to the Master's degree | Ranking based on the compatibility of the undergraduate degree | Coefficient assigned to the undergraduate degree |
|---|---|---|---|---|
| Metallurgy | Metallurgical Engineering | Metallurgy | **1** | **1.00** |
| | | Materials Engineering | **2** | **0.80** |
| | | Mechanical Construction | **3** | **0.70** |
| | | Process Engineering | **4** | **0.65** |
| | | Materials Physics | **4** | **0.65** |
| | | Materials Chemistry | **4** | **0.65** |
| | | Other degrees in the field of Science and Technology" | **5** | **0.60** |

## II - Semester-based organization sheets for the specialty's teachings

**Semester 1**

| Teaching Unit | Subjects | Credits | Coefficient | Weekly volume | | | Semester Hour Volume (15 Weeks) | Additional Work in Consultation (15 Weeks) | Evaluation Method | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Title | | | Lectures | Tutorial | Practice | | | Continuous Assessment | Exam |
| Fundamental T U<br>Code : FTU 1.1.1<br>Credits : 10<br>Coefficients : 5 | Theory of Metallurgical Processes | 6 | 3 | 3h00 | 1h30 | | 67h30 | 82h30 | 40% | 60% |
| | Plasticity and Metal Damage | 4 | 2 | 1h30 | 1h30 | | 45h00 | 55h00 | 40% | 60% |
| Fundamental T U<br>Code : FTU .1.1.2<br>Credits : 8<br>Coefficients : 4 | Physico-chemistry of Surfaces | 4 | 2 | 1h30 | 1h30 | | 45h00 | 55h00 | 40% | 60% |
| | Phase Transformation | 4 | 2 | 1h30 | 1h30 | | 45h00 | 55h00 | 40% | 60% |
| Methodological T U<br>Code : MTU 1.1<br>Credits : 9<br>Coefficients : 5 | Theory of Metallurgical Processes | 2 | 1 | | | 1h30 | 22h30 | 27h30 | 100% | |
| | Radiocristallography | 3 | 2 | 1h30 | | 1h00 | 37h30 | 37h30 | 40% | 60% |
| | Mechanical Properties of Metals | 4 | 2 | 1h30 | | 1h30 | 45h00 | 55h00 | 40% | 60% |
| Discovery T U<br>Code : DTU 1.1<br>Credits : 2<br>Coefficients : 2 | Elective Subject | 1 | 1 | 1h30 | | | 22h30 | 02h30 | | 100% |
| | Elective Subject | 1 | 1 | 1h30 | | | 22h30 | 02h30 | | 100% |
| Transversal T U<br>Code : TTU 1.1<br>Credits : 1<br>Coefficients : 1 | Technical English and Terminology | 1 | 1 | 1h30 | | | 22h30 | 02h30 | | 100% |
| **Semester Total1** | | **30** | **17** | **15h00** | **6h00** | **4h00** | **375h00** | **375h00** | | |

**Semestre 2**

| Teaching Unit | Subjects | Credits | Coefficient | Weekly volume | | | Semester Hour Volume (15 Weeks) | Additional Work in Consultation (15 Weeks) | Evaluation Method | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Title | | | Lectures | Tutorial | Practice | | | Continuous Assessment | Exam |
| Fundamental T U<br>Code : FTU 1.2.1<br>Crédits : 8<br>Coefficients : 4 | Phase Equilibrium | 4 | 2 | 1h30 | 1h30 | | 45h00 | 55h00 | 40% | 60% |
| | Direct reduction of ore | 4 | 2 | 1h30 | 1h30 | | 45h00 | 55h00 | 40% | 60% |
| Fundamental T U<br>Code : FTU 1.2.2<br>Crédits : 10<br>Coefficients : 5 | Metallic Materials | 6 | 3 | 3h00 | 1h30 | | 67h30 | 82h30 | 40% | 60% |
| | Powder Metallurgy | 4 | 2 | 3h00 | | | 45h00 | 55h00 | | 100% |
| Methodological T U<br>Code : MTU 2.1<br>Crédits : 9<br>Coefficients : 5 | Powder Metallurgy | 2 | 1 | | | 1h30 | 22h30 | 27h30 | 100% | |
| | Surface Engineering | 3 | 2 | 1h30 | | 1h00 | 37h30 | 37h30 | 40% | 60% |
| | Foundry Technology | 4 | 2 | 1h30 | | 1h30 | 45h00 | 55h00 | 40% | 60% |
| Discovery T U<br>Code : DTU 2.1<br>Crédits : 2<br>Coefficients : 2 | Optional Subject | 1 | 1 | 1h30 | | | 22h30 | 02h30 | | 100% |
| | Optional Subject | 1 | 1 | 1h30 | | | 22h30 | 02h30 | | 100% |
| Transversal T U<br>Code : TTU 2.1<br>Crédits : 1<br>Coefficients : 1 | Compliance with Standards and Ethical Rules" | 1 | 1 | 1h30 | | | 22h30 | 02h30 | 40% | 60% |
| **Semester Total 2** | | **30** | **17** | **16h30** | **4h30** | **4h00** | **375h00** | **375h00** | | |

**Semester 3**

| Teaching Unit | Subjects | Credits | Coefficient | Weekly volume | | | Semester Hour Volume (15 Weeks) | Additional Work in Consultation (15 Weeks) | Evaluation Method | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Title | | | Lectures | Tutorial | Practice | | | Continuous Assessment | Examen |
| Fundamental T U<br>Code: FTU 2.1.1<br>Credits: 10<br>Coefficients: 5 | Steel Electrometallurgy and Ferroalloys | 6 | 3 | 3h00 | 1h30 | | 67h30 | 82h30 | 40% | 60% |
| | Innovative Materials | 4 | 2 | 3h00 | | | 45h00 | 55h00 | | 100% |
| Fundamental T U<br>Code : FTU 2.1.2<br>Credits: 8<br>Coefficients: 4 | Welding Metallurgy | 4 | 2 | 1h30 | 1h30 | | 45h00 | 55h00 | 40% | 60% |
| | Non-Metallic Materials | 4 | 2 | 1h30 | 1h30 | | 45h00 | 55h00 | 40% | 60% |
| Methodological T U<br>Code: MTU 2.1<br>Credits: 9<br>Coefficients: 5 | Welding Metallurgy and Controls | 2 | 1 | | | 1h30 | 22h30 | 27h30 | 100% | |
| | Non-Ferrous Metals and Alloys | 3 | 2 | 1h30 | | 1h00 | 37h30 | 37h30 | 40% | 60% |
| | Metal Forming | 4 | 2 | 1h30 | | 1h30 | 45h00 | 55h00 | 40% | 60% |
| Discovery T U<br>Code: DTU 2.1<br>Credits: 2<br>Coefficients: 2 | Optional Subject | 1 | 1 | 1h30 | | | 22h30 | 02h30 | | 100% |
| | Optional Subject | 1 | 1 | 1h30 | | | 22h30 | 02h30 | | 100% |
| Transversal T U<br>Code : DTU 2.1<br>Credits: 1<br>Coefficients: 1 | Documentary Research and Thesis Design | 1 | 1 | 1h30 | | | 22h30 | 02h30 | | 100% |
| **Semester Total 3** | | **30** | **17** | **16h30** | **4h30** | **4h00** | **375h00** | **375h00** | | |

**The elective course basket for the discovery subjects in S1, S2, and S3:**

1- Introduction to Process Engineering
2- Metallographic Solutions
3- Materials Observation and Control Techniques
4- Computers and Application Software
5- Numerical Computation and Modeling
6- Business Management
7- Health and Environment in Metallurgy
8- Anticorrosion Processes
9- Non-Destructive Surface Inspection
10- Industrial Furnaces
11- CAD in Metallurgy
12- Metal Recycling
13- Hydrometallurgy.

**Semester 4**

Internship in a company or research laboratory culminating in a thesis and a presentation.

| | SHV | Coeff | Credits |
|---|---|---|---|
| Personal Work | 550 | 09 | 18 |
| Internship in a company or laboratory | 100 | 04 | 06 |
| Seminars | 50 | 02 | 03 |
| Other (Supervision) | 50 | 02 | 03 |
| Total Semester 4" | 750 | 17 | 30 |

**This table is provided as an indication.**

**Assessment of Master's Final Project**

- Scientific Value (Assessment by the Jury) /6
- Thesis Writing (Assessment by the Jury) /4
- Presentation and Q&A Session (Assessment by the Jury) /4
- Supervisor's Assessment /3
- Internship Report Presentation (Assessment by the Jury) /3

## III - Detailed syllabus by subject for semester S1.

**Semester: 1**
**Fundamental Teaching Unit: FTU 1.1.1**
**Subject 1: Theory of metallurgical processes**
**SHV: 67h30 (Course: 3h00, tutorial: 1h30)**
**Credits: 6**
**Coefficient: 3**

## Objective of teaching:

This matter allow has the student of put in application the knowledge acquired in chemistry physics, in particular the notions of thermodynamics. He will get to know the different solutions existing in metallurgy such as liquid metal, as well as concepts on structure of the dairy and metals.

## Knowledge prerequisites recommended:

- Chemistry physical, chemistry general, chemistry mineral

## Subject Content:

**Chapter 1 :** (3 weeks)
– The solutions ideal,
Energy of Gibbs of the components
There law of Raoult And of Henry. Solutions real, potential chemical of the components
Pressure of steam of the components In the real solutions, activity of the components
State standard of their substance pure and solutions to 1%

**Chapter 2.** (2 weeks)
2.1- There reaction isothermal of Van Hoff
2.2 Thermal dissociation of the components of a gas,
2.3-Pressure balance of a gas

**Chapter 3** (2 weeks)
3.1- Process of dissociation and of training of the carbonates3.2-
Process of dissociation and of training of the oxides
3.3- Process of dissociation and of formation of sulphides.

**Chapter 4** (2 weeks)
4.1- Thermodynamics of there combustion of carbon
4.2- Thermodynamics of the combustion of the oxides of carbon

**Chapter 5** (1 week)
The diagram of Ellingham and his applications.

**Chapter 6** (2 weeks)
6.1 - Theory of reduction of the oxides of iron – Essential reactions.

**Chapter 7** (3 weeks)
7.1- Kinetic of the process homogeneous and heterogeneous:-Applications
7.2-.Slag theory:-Structure,-Diagrams, -Analysis and properties.
7.3- Balance in the system metal-slag.

## Fashion evaluation:

- Control continuous below shape of micro questions and examination half-yearly writing
- Projects personal and exposed

Control continuous : 40% ; Exam : 60%.

## References bibliographic

1- Theory of metallurgical processes" SI Filipov . Edition Mir. 1975
2- Metallurgical process engineering » Authors: **Yin** , Ruiyu , 2011

**Semester: 1**
**Fundamental Teaching Unit: FTU 1.1.1**
**Subject 2: Plasticity and Damage of Metals**
**SHV: 45 hours (Lecture: 1 hour 30 minutes, Tutorial: 1 hour 30 minutes)**
**Credits: 4**
**Coefficient: 2**

## Objectives of the Course:

This course aims to introduce students to the understanding of the mechanical behavior of metals. It specifically aids in comprehending the physical origin of behavioral laws and their governing parameters. Topics covered include elasticity, yield strength, plastic deformation, and fracture. Upon completion, students should be capable of applying this knowledge, such as in analyzing a case of fracture.

## Recommended Prerequisite Knowledge:

Strength of Materials, Mathematics, Physical Sciences, Crystallography

## Subject Content:

| | |
|---|---|
| Chapter 1: Crystal Imperfections | (2 weeks) |
| Chapter 2: Perfect Dislocations | (1 week) |
| Chapter 3: Dislocations in FCC lattices | (2 weeks) |
| Chapter 4: Plastic Deformation of Pure Single Crystals | (1 week) |
| Chapter 5: Plastic Deformation of Polycrystals | (1 week) |
| Chapter 6: Plastic Deformation of Polycrystals | (2 weeks) |
| Chapter 7: Deformation of Solid Solutions | (2 weeks) |
| Chapter 8: Deformation of Alloys Containing Two Phases | (1 week) |
| Chapter 9: Deformation of Polycrystals Containing a Second Phase | (1 week) |
| Chapter 10: Creep and Rupture of Metals | (2 weeks) |

## Evaluation Method:

Continuous assessment through quizzes and a written semester exam

Personal projects and presentations

Continuous assessment: 40%; Exam: 60%.

## Bibliography References:

1. « Plasticité, fatigue et rupture des matériaux métalliques » Cardou Alain. Edition Longueil, Quebec, 2006
2. Physique et mécanique de l'endommagement. F Montheillet. 2012. EDP Sciences.

**Semester: 1**
**Fundamental Teaching Unit: FTU 1.1.2**
**Subject: Surface physical-chemistry**
**SHV: 45h (Course: 1h30, tutorial: 1h30)**
**Crédits : 4**
**Coefficient : 2**

## Teaching objectives:

Make known the existence of surface tension as an essential parameter involved in interfacial interactions. Description of the phenomenon of gas adsorption on the surface of solid and liquid metals through the laws of thermodynamics. Application to the determination of the surface area and pore volume of solids.

## Prerequisite knowledge:

Mathematics, chemical kinetics, basics of thermodynamics.

## Subject matter content:

**Chapter 1: Surface phenomena** **(4 weeks)**

1.1 Surface tension and surface free energy
1.2 Surface tension and thermodynamic functions
Surface tension vs temperature
Laplace equation
Kelvin equation
1.3 Methods for measuring surface tension

**Chapitre 2 : Tension de surface et tension interfaciale** **(3 semaines)**

2.1 Isotherme de Gibbs - concentration superficielle.
2.2. Pression de surface

**Chapter 3: Physico-chemical study of surfactant activity** **(3 weeks)**

3.1 Adhesion work - cohesion work.
3.2 Contact angle - Young's equation
3.3 Wetting

**Chapter 4 Adsorption phenomenon** **(3 weeks)**

4.1 Definition
4.2 Van der Waals forces
4.3 Method of measurements
4.4 Adsorption isotherms
4.5 Langmuir isotherm
4.6 Freundlich isotherm
4.7 Evaluation of specific surface area

**Chapter 5 Competitive adsorption and heterogeneous kinetics** **(2 weeks)**

5.1 Competitive adsorption
5.2 Heat of adsorption
5.3 Langmuir-Hinshelwood model
5.4 Eley-Rideal model

## Assessment Method:

Continuous assessment: 40%; Exam: 60%.

## Bibliographical References:


1. C. E. CHITOUR, Physico-chimie des surfaces, OPU.
2. J.M. Coulson, J.F. Richardson, Backhurst, Harker, Chemical engineering, Pergamon Press.
3. J. Fripiat, J. Chaussidon, A. Jelli, Chimie-physique des phénomènes de surface, Masson.

**Semester: 1**
**Fundamental Teaching Unit: FTU 1.1.2**
**Subject 2: phase transformation**
**SHV: 45h00 (Course: 1h30, tutorial: 1h30)**
**Credits: 4**
**Coefficient: 2**

**Teaching objectives:**

This teaching will allow the student to learn the mechanisms that take place in a metal, the different possible transformations that take place there. On the other hand, this information will allow it to choose, for example, the appropriate heat treatment.

**Recommended prior knowledge:**

Basics of thermodynamics, physical metallurgy

**Material content:**

| | |
|---|---|
| **Chapter 1** Nucleation of a new phase | (2 weeks) |
| **Chapter 2** Growth | (1 week) |
| **Chapter 3**. Coarsening | (1 week) |
| **Chapter 4**. Global kinetics of transformation | (2 weeks) |
| **Chapter 5** Spinodal decomposition | (1 week) |
| **Chapter 6** Transition phases | (1 week) |
| **Chapter 7** Discontinuous precipitation | (1 week) |
| **Chapter 8** Eutectoid Transformation | (2 weeks) |
| **Chapter 9** Massive Transformation | (1 week) |
| **Chapter 10** Order – disorder transformations | (1 week) |
| **Chapter 11** Martensitic transformation | (2 weeks) |

**Evaluation method:**

- Continuous assessment in the form of micro-questions and half-yearly written exam
- Personal projects and presentations

Continuous monitoring: 40%; Exam: 60%.

**Bibliographic references**

1- D.A. PORTER, K.E. EASTERLING, Phase Transformation in Metals and Alloys, 2nd ed., Chapman & Hall, London., 1992

2- Phase transformations in solids. R. Smoluchowki. Acta cristallica. 2002

**Semester: 1**
**Methodological Teaching Unit: MTU 1.1**
**Subject 1: Theory of metallurgical processes**
**SHV: 10:30 p.m. (TP: 1:30 a.m.)**
**Credits: 2**
**Coefficient: 1**

**Objective of teaching:**

This teaching will allow the student to implement theoretical knowledge acquired of the matter Theory of the process metallurgical between others the process carbonate dissociation, oxidation, etc.

**Knowledge prerequisites recommended:**

Theory of the process metallurgical, Chemistry physical

**Content of matter:**

**Work practical n°1** **(2 Weeks)**
Study of the dissociation of the carbonates of kind MeCO 3

**Work practical n°2** **(3 Weeks)**
Study of the kinetic of oxidation isothermal of the metals

**Work practical No. 3** **(2 Weeks)**
Determination of the balance of the reactions chemical in the systemsmetallurgical

**Work practical No. 4** **(3 Weeks)**

Experimental determination of the characteristics of metallurgical reactions andof the reagents

**Work practical No. 5** **(2 Weeks)**
Study of the process heterogeneous in using the method of thermogravimetry

**Work practical No. 6** **(3 Weeks)**
Methods of determination of the settings interaction _ In the bath metallic

**Evaluation method:**

Control continuous below shape of defense of works practice

Control continuous: 100%

**References bibliographic**

1“Theory of metallurgical processes” SI Filipov . Edition Mir. 1975

2« Metallurgical process engineering » Authors: Yin , Ruiyu , 2011

**Semester: 1**
**Methodological teaching unit: MTU1.1**
**Matter 2: Radiocristallography**
**SHV: 37h30 (Courses: 1h30, tutorial:1h00)**
**Credits: 3**
**Coefficient: 1**

## Objectives:

Apprehend the main concepts of radiocristallography (Solid state physics and chemistry,X-ray diffraction)

## Recommended prior knowledge:

Physical sciences, crystallography, general and mineral chemistry.

## Content:

**Chapter 1: Basic concepts about radiation and matter** **(3 weeks)**

1- Generalities about radiation and matter

2- Properties of X-ray radiation

3- Interaction of X-rays and matter

4- Properties of electrons and neutrons

**Chapter 2: Diffraction of X-rays by a perfect crystal** **(3 weeks)**

1- Wave function and diffusion

2- Geometric theory of diffraction

3- Kinematic theory of diffraction

**Chapter 3: The powder method** **(5 weeks)**

1- Principles of measurement

2- Geometry of diffraction, and Ewald sphere

3- The circle of focusing

4- Diffracting crystallites

5- Search and selection of phases

6- The dosage of the phases, and surface of the peaks

7- Preferential orientations and texture measurement

8- Residual stress measurement

**Chapter 4 : Analysis of single crystals** **(2 weeks)**

1- Laue's Method

**Chapter 5: Elemental analysis by X-ray fluorescence** **(2 weeks)**

## Evaluation method:

Continuous assessment in the form of micro-questions and biannual written exam.
Continuous assessment: 40%; Examination: 60%.

## References bibliographic

1. AZAROFF L. V. BUERGER M. J. – The powder method in x-ray crystallography, McGraw-Hill, New-York (1958).
2. BACON G. E. – Neutron Diffraction. Oxford University Press, New-York (1975). BORCHARDT – OTT W. – Crystallography. Springer-Verlag, Berlin (1993).

**Semester: 1**
**Methodological teaching unit: MTU1.1**
**Subject 3: Mechanical Properties of Metals**
**SHV: 45 hours (Lecture: 1.5 hours, Practical Work: 1.5 hours)**
**Credits: 4,**
**Coefficient: 2**

## Teaching Objectives:

Understanding the measurement of various mechanical properties and their significance for a metal. A precise understanding of the nature of dislocations and their role in the process of plastic deformation enables comprehension of underlying mechanisms used to enhance the strength and hardness of metals and their alloys. This knowledge aids in defining the necessary mechanical properties for a material, such as conferring strength or toughness to a metal matrix composite.

## Recommended Prerequisite Knowledge:

Physical metallurgy, strength of materials, crystallography

## Subject Content:

| | |
|---|---|
| Chapter 1: Generalities on the mechanical properties of metals | (2 weeks) |
| Chapter 2: Influence of defects on metal properties | (2 weeks) |
| Chapter 3: Crystal lattice defects and deformation mechanisms | (2 weeks) |
| Chapter 4: Metal strengthening mechanisms | (2 weeks) |
| Chapter 5: Recovery | (1 week) |
| Chapter 6: Recrystallization | (1 week) |
| Chapter 7: Thermal activation (deformation) | (1 week) |
| Chapter 8: Creep | (1 week) |
| Chapter 9: Metal fatigue | (1 week) |
| Chapter 10: Metal fracture | (1 week) |
| Chapter 11: Mechanical tests on metals | (1 week) |

## Assessment Method:

Continuous assessment through quizzes and a semester-end written exam
Practical Work presentation
Continuous assessment: 40%; Exam: 60%.

## Bibliographical References:

1. J. Philibert et J. Talbot, J. Benard, A. Michel, Métallurgie Générale, Masson, 1991
2. Jean Philibert, Yves Bréchet, Alain Vignes, Pierre Combrade, Métallurgie du minerai au matériau, Masson, Paris 1998
3. Yves Quéré, Physique des matériaux, Edition Marketing (ellipses) 1988
4. Wiliam D. Callister, Jr, Science et Génie des Matériaux, 5e Edition, Dunod, Modulo Editeur 2001

**Semester: 1**
**Discovery Teaching Unit: DTU1.1**
**Subject 1:**
**SHV: 22 hours 30 minutes (Lecture: 1 hour 30 minutes)**
**Credits: 1**
**Coefficient: 1**

**Semester: 1**
**Discovery Teaching Unit: DTU1.1**
**Subject 2:**
**SHV: 22 hours 30 minutes (Lecture: 1 hour 30 minutes)**
**Credits: 1**
**Coefficient: 1**

**Semester: 1**
**Transversal Teaching Unit: UET 1.1**
**Subject 1: Technical English and Terminology**
**SHV: 22 hours 30 minutes (Lecture: 1 hour 30 minutes)**
**Credits: 1**
**Coefficient: 1**

**Objectives of the Course:**

Initiate students to technical vocabulary, reinforce their language knowledge, aid in understanding and summarizing technical documents, and enable comprehension of scientific conversations in English.

**Recommended Prerequisite Knowledge:**

Basic vocabulary and grammar in English

**Subject Content:**

**1.** Written Comprehension: Reading and analysis of texts related to the specialty. **(4 weeks)**

2. Oral Comprehension: Using authentic scientific video materials, note-taking, summarizing, and presenting the content. **(3 weeks)**

3. Oral Expression: Presenting a scientific or technical topic, exchanging oral messages (ideas and data), telephone communication, and non-verbal communication. **(3 weeks)**

4. Written Expression: Extracting ideas from scientific documents, writing scientific messages, exchanging information in writing, writing resumes, cover letters for internships or jobs **(5weeks)**

**Evaluation Method:**

Exam: 100%.

**Bibliographic References:**


1. P.T. Danison, Guide pratique pour rédiger en anglais : usages et règles, conseilspratiques, Editions d'Organisation 2007
2. A. Chamberlain, R. Steele, Guide pratique de la communication : anglais, Didier 1992
3. R. Ernst, Dictionnaire des techniques et sciences appliquées : français-anglais, Dunod 2002.
4. J. Comfort, S. Hick, and A. Savage, Basic Technical English, Oxford University Press, 1980
5. E. H. Glendinning and N. Glendinning, Oxford English for Electrical and Mechanical Engineering, Oxford University Press 1995
6. T. N. Huckin, and A. L. Olsen, Technical writing and professional communication for nonnative speakers of English, Mc Graw-Hill 1991 7. J. Orasanu, Reading Comprehension from Research to Practice, Erlbaum Associates 1986

# Detailed syllabus by subject for semester S2.

**Semester: 2**
**Fundamental Teaching Unit: FTU 1.2.1**
**Subject 1: Phase Equilibrium**
**SHV: 45 hours (Lecture: 1.5 hours, Tutorial: 1.5 hours)**
**Credits: 4**
**Coefficient: 2**

## Course Objectives:

This chapter aims to understand the construction of binary phase diagrams and recall the various types of possible phase diagrams. With this knowledge, one can explain the significance of alloys and the variations in their mechanical properties based on compositional changes.

## Prerequisite Knowledge:

Inorganic Chemistry, General Chemistry, Physical Metallurgy

## Course Content:

**Introduction and Definitions**

**I Construction of a Phase Diagram (2 weeks)**

**II Phase Diagrams with Complete Solid Solubility (5 weeks)**

Determination of phase composition, Determination of the proportion (by mass) of each phase,

Diagrams with eutectic points, microscopic appearance of phase a or phase b

**III Micrographic appearance of a hypoeutectic alloy or a hypereutectic alloy. (5 weeks)**

**IV Special Cases (3 weeks)**

- Diagrams with eutectoid points
- Diagrams with peritectic points
- Diagrams with peritectoid points

## Evaluation Method:

Continuous assessment through quizzes and semester-end written exams
Continuous assessment: 40%; Exam: 60%.

## Bibliographic References

1- Thermodynamique appliquée **-** Diagrammes de phases - Équilibres chimiques.
2- Systèmes unaires, binaires, ternaires - Cours et applications Broché – 2017**.** KolsiAbdel Waheb
3- Thermodynamique des équilibres entre les phases. Mounir Bennajah et autres. Technip. 2015
4- Diagrammes d'équilibre. Alliages binaires. Jean Hertz. 1999

**Semester: 2**
**Fundamental Teaching Unit: FTU 1.2.1**
**Subject 2: Direct reduction of ore**
**SHV: 45h00 (Course: 1h30, tutorial: 1h30)**
**Credits: 4**
**Coefficient: 2**

## Objective of teaching

The objective of this matter East to study the metallurgy of iron according to the fashion direct Before the top furnace, in others words learn to students A fashion of obtaining of pre reduced ferrous different from classic products.

## Knowledge prerequisites :

Chemistry mineral, Chemistry general, metallurgy physical

## Content of the matter :

1. **Principle of the direct reduction** (5 weeks)
   - Aspects stoichiometric
   - Aspects thermochemical
   - Aspects thermodynamics
   - Kinetic of the reduction oxides of iron
   - Reduction by the gas
   - Reduction by the carbon
2. **Development global of the reduction direct** (2 weeks)
   - Food of the steel industry in metals primary
   - Motives of the rise of the reduction direct
3. **Location worldwide of the units** (2 weeks)
4. **Transportation and trade global of the minerals reduced** (1 week)
5. **Evolution of the processes** (4 weeks)

## Evaluation method:

Control continuous: 40%; Exam: 60%

## References bibliographic

1- Traitement des minerais. Bouchard Serge. Modulo. 2007
2-Techniques de l'ingénieur. M7580 v4. 2005

**Semester: 2**
**Fundamental Teaching Unit: FTU: 1.2.2**
**Subject 1: Metallic materials**
**SHV: 67h30 (Lecture: 3h00, tutorial: 1h30 )**
**Credits: 6**
**Coefficient: 3**

## Teaching objectives:

Learn about metallic materials such as steels, cast irons, heavy and light metal alloys

## Prior knowledge:

General chemistry, crystallography, physical metallurgy

## Content of the material:

**I. Iron and its alloys:**

| | |
|---|---|
| 1-White cast iron, gray cast iron, hardened cast iron, malleable cast iron | (2 weeks) |
| 2_ Steels: classification of steels, standards | (2 weeks) |

**II. Non-ferrous metals and alloys**

| | |
|---|---|
| 1-Light and ultra-light alloys | (2 weeks) |
| 2-White alloys, | (1 week) |
| 3-heavy alloys; | (2 weeks) |
| 4-Special alloys; | (2 weeks) |
| 5-Superalloys | (2 weeks) |
| 6-Shape memory alloys | (1 week) |
| 7-Criterion for choosing a material. | (1 week) |

## Evaluation method:

Continuous evaluation in the form of micro-questions and half-yearly written exam
Continuous control: 40%; Exam: 60%.

## Bibliographic references


1- Matériaux métalliques. 2ème édition. M. Colombié. 2017
2- Matériaux industriels- matériaux métalliques. . M. Colombié. 2003. Dunod

**Semester: 2**
**Fundamental Teaching Unit 1.2.2**
**Subject 2: Powder Metallurgy**
**SHV: 45 hours (Lecture: 3 hours)**
**Credits: 4**
**Coefficient: 2**

## Teaching Objectives:

Students will become familiar with manufacturing techniques that involve processes other than shaping by deformation or casting.

## Prerequisite Knowledge:

Chemical thermodynamics, physical metallurgy, heat treatments, extractive metallurgy

## Subject Content:

1- Introduction (1 Week)

2- Theory and technique of powder preparation (1 Week)

3- Powder characteristics, tests, and trials (2 Weeks)

4- Cold powder shaping: agglomeration, compacting (1 Week)

5- Sintering theory, mechanisms, and physico-chemical aspects of solid-phase sintering (3 Weeks)

6- Other types of sintering. Sintered materials (2 Weeks)

7- Furnaces, sintering installations, and finishing of parts (3 Weeks)

8- Applications (1 Week)

9- Porous products (2 Weeks)

## Assessment Method:

Exam : 100%.

## Bibliographic references

1- Métallurgie des poudres. Didier Bouvard. Hermes. 2002.
2- Powder metallurgy . Institute of metals. 1991. London. Ivor Jenkins

**Semester: 2**
**Methodological Teaching Unit: MTU 1.2**
**Subject 1: Powder Metallurgy (Practical work )**
**SHV: 22 hours and 30 minutes (Practical work : 1 hour and 30 minutes)**
**Credits: 2**
**Coefficient: 1**

## Objectives of Teaching:

The aim is to reinforce theoretical knowledge through practical work.

## Recommended Prerequisite Knowledge:

## Subject Content:

1- Determination of technological properties of powders (3 weeks)

2- Determination of particle size distribution by sieving (2 weeks)

3- Determination of particle size distribution using a microscope (2 weeks)

4- Determination of the volumetric distribution of density within the agglomerate (2 weeks)

5- Sintering of metallic powders (3 weeks)

6- Characterization of sintered metallic powders (3 weeks)

## Assessment Method:

Continuous assessment through practical work presentations

Continuous Assessment: 100%

**Semester: 2**
**Methodological Teaching Unit: MTU 1.2**
**Subject 2: Surface Engineering**
**SHV: 37h30 (Lectures: 1h30, Lab Work: 1h00)**
**Credits: 3**
**Coefficient: 2**

## Objectives of the Course:

Students will gain familiarity with surface treatment processes for metals and steels that enhance surface properties, including surface coatings for ferrous metals.

## Recommended Prerequisite Knowledge:

Heat treatments of ferrous metals, physical metallurgy

## Course Content:

**I- Surface Heat Treatments for Ferrous Alloys: (8 Weeks)**

1. Treatments without a change in chemical composition (quenching after local heating)
2. Induction treatments
3. Joule effect treatments
4. Treatments using a plasma torch
5. Electron bombardment treatments
6. Laser beam treatments
7. Solar radiation treatments
8. Treatments involving changes in composition
9. Classic and ionic thermochemical treatments (carburizing, carbonitriding, nitrocarburizing, boriding)

**II- Mechanical Treatments: (3 weeks)**

1. Shot peening
2. Hammering
3. Rolling

**III- Coatings: (5 weeks)**

1. Particle deposition (thermal spraying)
2. Massive coatings (weld overlay, immersion in molten metal, hard chromium plating)
3. Atomic depositions (PVD, CVD)

## Laboratory Work:

Treatments without a change in chemical composition (quenching after local heating)
Induction treatments
Joule effect treatments
Classic and ionic thermochemical treatments (carburizing, carbonitriding, nitrocarburizing, boriding)
Massive coatings (weld overlay, immersion in molten metal, hard chromium plating)

## Evaluation Method:

Continuous assessment via quizzes, presentations, and a written semester exam.
Continuous assessment: 40%; Exam: 60%.

## References Bibliography


1. Procédés industriels de traitement de surfaces par voie plasma: Génie des procédés plasmas et traitement de surfaces . Broché 2016. A. Mamadou Talla. Paf
2. Traitements de surfaces des aciers. A Queruel. Dunod. 2007
3. Traitements et revêtements des surfaces des métaux. Dunod. Technique et ingénierie.2013

**Semester: 2**
**Methodological Teaching Unit: MTU 1.2**
**Subject 3: Foundry technology**
**SHV:37h30 (Course: 1h30, Practical work: 1h30)**
**Credits: 4, Coefficient: 2**

## Objective of teaching:

Get to know the processes for transforming liquid metals into parts;to know the kind of materials used in foundry……..

## Knowledge prerequisites:

Chemistry general And mineral, geometry descriptive, elaboration of the metals

## Content of the matter :

**History** **(1 Week)**

**I. Role and possibilities of the foundry:** **(1 Week)**
- Composition of alloys, Pieces

**II. Methods of manufacturing And industrial process:** **(2 Weeks)**
- -Process industrial, Plan of principle of the manufacturing of parts of foundry

**III. Materials of casting:** **(1 Week)**
- -Sands of base, Binders, Materials For mussels permanent, Products specials

IV. **Molding to remaining sands plastics:-** **(2 Weeks)**
Sands of molding, manufacturing processes molding

**V. Molding has models lost:-Casting with models in polystyrene expanded,** **(2 Weeks)**
- Molding has the wax lost

**VI. Molding in mussels metal:-General- Features general** **(1 Week)**
*1-* Coring: -General-Different processes of coring (1 Week)
*2-* Metal alloys used in foundry : (4 weeks)
-Alloys ferrous-Alloys No ferrous

**Works practice**
- Characterization of a sand of molding
- Preparation of a mold in sand
- Casting of a piece in a mold in sand
- Molding has the wax lost
- Molding in metal molds

## evaluation method:

- Control continuous below shape of microphone questions, exposed And exam half-yearly writing.

-Control continuous : 40%; Exam : 60%.

## References bibliographic

1- Moulage et fonderie d'art. Daniel Lambert. Edition Val. 2003

2- La fonderie, ses techniques, ses possibilités. A Reynaud. Editions techniques. 2004

***Semester 2:***
***Discovery Teaching Unit: DTU.2.1***
***Subject 1: Elective Course Selection***
***SHV: 22h30 (Lectures: 1h30)***
***Credits: 1***
***Coefficient: 1***

***Semester 2:***
***Discovery Teaching Unit: DTU.2.1***
***Subject 1: Elective Course Selection***
***SHV: 22h30 (Lectures: 1h30)***
***Credits: 1***
***Coefficient: 1***

**Semester: 2**
**Transversal Teaching Unit: TTU 1.2**
**Subject: Compliance with Standards and Ethical Rules**
**SHV: 22h30 (Lecture: 1h30)**
**Credit: 1**
**Coefficient: 1**

## Objectives of Teaching:

To develop students' awareness of ethical principles and the rules governing life in both university and the professional world. This includes fostering respect and appreciation for intellectual property, explaining the risks associated with moral issues such as corruption and ways to combat them, and raising awareness of ethical issues raised by new technologies and sustainable development.

## Recommended Prerequisites:

Ethics and Deontology (Foundations)

## Course Content:

**A. Respect for Ethical Rules and Integrity:** Overview of the Ethics and Deontology Charter of the Ministry of Higher Education and Scientific Research: Integrity and honesty. Academic freedom. Mutual respect. Demand for scientific truth, Objectivity, and critical thinking. Fairness. Rights and obligations of students, teachers, administrative, and technical staff.

**B. Responsible and Ethical Research:**
Adherence to ethical principles in teaching and research
Responsibilities in teamwork: Professional equality of treatment.
Conduct against discrimination. Pursuit of the general interest.
Inappropriate conduct in collective work
Adopting responsible conduct and combating deviations: Adopting responsible conduct in research. Scientific fraud. Measures against fraud. Plagiarism (definition, various forms, procedures to avoid unintentional plagiarism, plagiarism detection, sanctions against plagiarists, ...). Falsification and fabrication of data.

**C. Ethics and Deontology in the Workplace:**
Legal confidentiality in the business environment. Loyalty to the company. Responsibility within the company, conflicts of interest. Integrity (work-related corruption, its forms, consequences, methods of combating, and sanctions against corruption)

**B- Intellectual Property**
**I- Fundamentals of Intellectual Property**
Industrial property. Literary and artistic property.
Rules for citing references (books, scientific articles, congress communications, theses, dissertations, ...)

**II- Copyright**
Copyright in the digital environment
Introduction. Copyright of databases, copyright of software. Specific case of open-source software.
Copyright on the internet and e-commerce
Domain name rights. Intellectual property on the internet. Rights of e-commerce sites. Intellectual property and social networks.
Patent
Definition. Rights in a patent. Utility of a patent. Patentability. Patent application in Algeria and worldwide.

**III- Protection and Enhancement of Intellectual Property**
How to protect intellectual property. Violation of rights and legal tools. Enhancement of intellectual property. Protection of intellectual property in Algeria.
C. Ethics, Sustainable Development, and New Technologies
Link between ethics and sustainable development, energy conservation, bioethics, and new technologies (artificial intelligence, scientific progress, humanoids, robots, drones, ...)

## Assessment Method:

Exam: 100%

## Bibliographic References:


1. *Charte d'éthique et de déontologie universitaires. https://www.mesrs.dz/documents/12221/26200/Charte+fran__ais+d__f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce*
2. *Arrêtés N°933 du 28 Juillet 2016 fixant les règles relatives à la prévention et la lutte contre le plagiat*
3. *L'abc du droit d'auteur, organisation des nations unies pour l'éducation, la science et la culture (UNESCO)*
4. *E. Prairat, De la déontologie enseignante. Paris, PUF, 2009.*
5. *Racine L., Legault G. A., Bégin, L., Éthique et ingénierie, Montréal, McGraw Hill, 1991.*
6. *Siroux, D., Déontologie : Dictionnaire d'éthique et de philosophie morale, Paris, Quadrige, 2004, p. 474-477.*
7. *Medina Y., La déontologie, ce qui va changer dans l'entreprise, éditions d'Organisation, 2003.*
8. *Didier Ch., Penser l'éthique des ingénieurs, Presses Universitaires de France, 2008.*
9. *Gavarini L. et Ottavi D., Éditorial. de l'éthique professionnelle en formation et en recherche, Recherche et formation, 52 \| 2006, 5-11.*
10. *Caré C., Morale, éthique, déontologie. Administration et éducation, 2e trimestre 2002, n°94.*
11. *Jacquet-Francillon, François. Notion : déontologie professionnelle. Letélémaque, mai 2000, n° 17*
12. *Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.*
13. *Galloux, J.C., Droit de la propriété industrielle. Dalloz 2003.*
14. *Wagret F. et J-M., Brevet d'invention, marques et propriété industrielle. PUF 2001*
15. *Dekermadec, Y., Innover grâce au brevet: une révolution avec internet. Insep 1999*
16. *AEUTBM. L'ingénieur au cœur de l'innovation. Université de technologie Belfort-Montbéliard*
17. *Fanny Rinck etléda Mansour, littératie à l'ère du numérique : le copier-coller chez les étudiants, Université grenoble 3 et Université paris-Ouest Nanterre la défense Nanterre, France*
18. *Didier DUGUEST IEMN, Citer ses sources, IAE Nantes 2008*
19. *Les logiciels de détection de similitudes : une solution au plagiat électronique? Rapport du Groupe de travail sur le plagiat électronique présenté au Sous-comité sur la pédagogie et les TIC de la CREPUQ*
20. *Emanuela Chiriac, Monique Filiatrault et André Régimbald, Guide de l'étudiant: l'intégrité intellectuelle plagiat, tricherie et fraude… les éviter et, surtout, comment bien citer ses sources, 2014.*
21. *Publication de l'université de Montréal, Stratégies de prévention du plagiat, Intégrité, fraude et plagiat, 2010.*
22. *Pierrick Malissard, La propriété intellectuelle : origine et évolution, 2010.*
23. *Le site de l'Organisation Mondiale de la Propriété Intellectuelle www.wipo.int*
24. *http://www.app.asso.fr/*

## III - Detailed syllabus by subject for semester S3.

**Semester :3**
**Fundamental Teaching Unit: FTU 2.1.1**
**Subject: Electrometallurgy of steel and ferroalloys**
**SHV :67h30 (Course: 3h00, tutorial: 1h30)**
**Crédits : 6, Coefficient :3**

**Teaching objectives:**

Learn in depth the constitution of liquid iron, and the influence of certain elements on its properties. Get to know the theory and practice of steelmaking.

**prerequisite knowledge:**

Chemistry, physical chemistry, general metallurgy.

**Subject matter content:**

**I– Constitution and physical properties of solutions diluted with liquid iron (2 weeks)**

I– 1 – Influence of addition elements on the properties of liquid and solid metals
I– 2 – Variation of the physical properties of liquid and solid metals under the influence of addition elements
I– 3 – Influence of oxygen on the structure and properties of liquid iron
I– 4 – Iron alloys – C
I– 5 – Fe – Ni alloys
I– 6 – Fe – Co alloys
I– 7 – Fe –Cr alloys

**II– Physico-chemical bases of steel production (3 weeks)**

II–1– Oxidation and reduction reactions
II–2– Oxidation of carbon
II–3– Oxidation and reduction of silicon
II–4– Oxidation and reduction of manganese
II–5– Oxidation and reduction of chromium
II–6– Oxidation of tungsten
II–7– Oxidation of phosphorus

**III– Desulfurization of steel (2 weeks)**

III– 1– Sulphur in steel
III– 2– The distribution of sulphur between the metal and the slag
III– 3– Influence of the chemical composition of the metal on desulfurization

**IV– Gases in steel (2 weeks)**

IV–1– Hydrogen in steel
IV–2– Nitrogen in steel

**V– Deoxidation of steel (2 weeks)**

V–1– Deoxidation methods
V–2– Interaction between deoxidizing elements and oxygen
V–3 – Formation and elimination of deoxidation products

**VI– Treatment of liquid steel in ladle furnace (4 weeks)**

VI–1 Vacuum steel processing
– Vacuum deoxidation of steel
– Elimination of non-metallic inclusions under vacuum
– Elimination of gases under vacuum
VI–2 Ladle steel desulfurization
–Treatment of liquid steel with synthetic slag
–Treatment of liquid steel with powders of alkaline earth elements

**Assessment Method**

Continuous assessment: 40%; Exam: 60%.

**Bibliographical References:**

1-Electrométallurgie de l'acier et ferroalliages. Polycopiés.
2-Théorie des processus métallurgiques électriques. Grigorian et autres. Moscou 1988.
3- Polycopiés : Les fours d'électrométallurgie. Jean Bistesi. 2008. Edition Desforges

**Semester: 3**
**Fundamental Teaching Unit: FTU 2.1.1**
**Subject 2: Innovative Materials**
**SHV: 45 hours (Lecture: 3 hours)**
**Credits: 4**
**Coefficient: 2**

## Teaching Objectives:

To introduce students to modern materials beyond metals, such as biomaterials and nanomaterials.

## Prerequisites:

Crystallography, general metallurgy, powder metallurgy

## Course Content:

**A– Biomaterials**

| | |
|---|---|
| I. Overview: Introduction, definition, classification | (3 weeks) |
| II. Utilization perspectives: Functions, bioactivity | |
| III. Elements of physiology and anatomy: Cells, living tissues. | |
| IV. Characterization of biomaterials: Mass-Surface | (1 week) |
| V. Tissue-material interactions: | (1 week) |
| Biocompatibility-Hemocompatibility | |
| VI. Materials for orthopedics: | (2 weeks) |
| Structure and mechanical properties of bone-Metals and alloys | |
| Ceramics, glasses, and mineral cements-Polymers and organic cements | |
| VII. Biocompatibility, biosafety, biofunctionality | (1 week) |

**B– Nanomaterials**

| | |
|---|---|
| I. Introduction to nanomaterials | (1 week) |
| II. Atoms, clusters, and nanomaterials | (2 weeks) |
| III. Preparation, synthesis: chemical, physical, biomimetic routes | (2 weeks) |
| IV. Properties of nanomaterials: Mechanical, chemical, magnetic, optical, electronic | (1 week) |
| V. Future applications | (1 week) |

## Assessment Method:

Exam : 100%.

## Bibliographical References:


1- *Les* biomatériaux. Lavoisier. Collection Biofutur.2012

2- *La révolution orthopédique des Biomatériaux. Lavoisier. 2005*

3- *Biomatériaux de substitution de l'os et du cartilage.1996. Expansion scientifique.*

4- *Nanomatériaux. Eric Gaffet. Techtendances 1998.*

5- *Les nanosciences. Tome 2. Phylipe Houdy. Nanomatériaux et nanochimie. 2006*

**Semester: 3**
**Fundamental Teaching Unit: FTU 2.1.2**
**Subject 1: Welding Metallurgy**
**SHV: 45 hours (Lecture: 1.5 hours, Tutorial: 1.5 hours)**
**Credits: 4**
**Coefficient: 2**

## Teaching Objectives:

Understanding the structure and composition of a weld and various welding techniques.

## Prerequisite Knowledge:

Physical metallurgy, electrical engineering, chemistry

## Subject Content:

1 Structure of a weld. Thermal, mechanical, and physicochemical aspects of welds. (2 weeks)

2 Heat treatments of welds: (2 weeks)
- 2.1 Preheating
- 2.2 Post-heating
- 2.3 Thermal relaxation

3 Welding of annealed, quenched, and tempered steels (1 week)

4 Metallurgy and weldability of non-ferrous metals and alloys (4 weeks)
- 4.1 Metallurgy and weldability of aluminum and its alloys
- 4.2 Metallurgy and weldability of nickel and its alloys
- 4.3 Metallurgy and weldability of titanium and its alloys
- 4.4 Metallurgy and weldability of stainless steels

5 Weldability of steels (4 weeks)
- 5.1 Mild steels
- 5.2 Low-alloy steels
- 5.3 Corrosion-resistant chromium-nickel steels
- 5.4 Refractory steels, plated steels.

6 Heat treatments and mechanical tests on welded assemblies (2 weeks)

## Assessment Method:

Continuous assessment: 40%; Exam: 60%."

## Bibliographical References:


1. Les bases métallurgiques du soudage. H.Granjon. 2000. Institut de soudage
2. Métallurgie et mécaniques du soudage. Lavoisier Hermes. 2001
3. Métallurgie du soudage des aciers inoxydables. R. Castro. Dunod.1968

**Semester: 3**
**Fundamental Teaching Unit: FTU 2.1.2**
**Subject 2: Non-Metallic Materials**
**SHV: 45 hours (Lectures: 1h30, Tutorials: 1h30)**
**Credits: 4**
**Coefficient: 2**

**Objectives of the teaching:**

To understand that apart from metals, there are other materials such as ceramics, glasses, or refractory materials that can replace steel or other metals.

**Prerequisite knowledge:**

Crystallography, physical metallurgy, mineral chemistry

**Content of the subject:**

A - Ceramics, Glasses, and Refractories

1. Traditional Ceramics: - Historical background, clay and pottery - Porcelain manufacturing - Specific cases of cements and concretes (1 week)
2. Elaboration of ceramics and techniques: - Powder technology - Shaping processes - Physics of densification by sintering - Sintering techniques - Microstructure control (2 weeks)
3. Properties and applications of technical ceramics: - Mechanical properties - Physical and chemical properties - Oxides, nitrides, carbides, composites - Other characteristic cases (2 weeks)
4. Mineral glasses: - Definitions and properties - Elaboration principles - Shaping methods - Recent technical innovations (1 week)
5. Glass ceramics: - LAS and MAS systems - Crystallization - Comparison between glass ceramics, glasses, and ceramics - Applications (1 week)
6. Refractories (2 weeks)

B - Polymer Materials and Composites (3 weeks)

I. Polymers Introduction

1. Chemical structures of molecular chains and networks
2. Physical structure of chains and distributions of molar masses
3. Polymer structures: - solids - amorphous - semi-crystalline
4. Mechanical behavior of solid polymer materials: - Viscoelasticity - Rubber elasticity - Glass transition depending on the molecular structure
5. Properties under tension and impact
6. Thermal properties

II. Composites (3 weeks)

1. Thermosetting composites
2. Thermoplastic composites
3. Semi-finished products
4. Silicones
5. Thermostructural composites: - Carbon-carbon composites - Metal matrix composites - Ceramic matrix composites
6. Natural composites
7. Nanocomposites

**Mode of assessment:**

Continuous assessment: 40%; Examination: 60%.

**References:**


1- Matériaux composites. Gay Daniel. 2015. Lavoisier Hermes.
2- Céramiques et verres. Traités des matériaux Vol 16. J .M Haussonne. 2002
3- Chimie et physico-chimie des polymères. M Fontanille. 2014. Dunod

**Semester: 3**
**Methodological Teaching Unit: MTU 2.1**
**Subject 1: Welding Metallurgy and Controls**
**SHV: 22.5 hours (Practice: 1.5 hours)**
**Credits: 2**
**Coefficient: 1**

**Teaching Objectives:**

Students will learn various welding and inspection techniques, focusing on a permanent assembly method.

**Recommended Prerequisite Knowledge:**

Crystallography, physical metallurgy, analysis, and control methods

**Subject Content:**

**Lab 1: Autogenous welding: (3 weeks)**

joining two metal pieces of the same material by melting them together and adding a filler metal of the same or higher quality.

**Lab 2: Heterogeneous welding: (6 weeks)**

using a different metal for welding than the pieces being joined

This lab covers four different welding types:

1- Oxy-acetylene welding

2- Shielded metal arc welding

3- Metal active gas (MAG) welding

4- Resistance spot welding

**Lab 3: Weld inspections (6 weeks)**

1. Non-destructive testing of welds:
   a. Study of the weld bead
   b. Dye penetrant inspection
   c. Radiographic or radiographic testing principles
   d. Ultrasonic testing
2. Destructive testing of welds

**Assessment Method:**

Continuous assessment: 100%"

**Semester:3**
**Methodological Teaching Unit: MTU 2.1**
**Subject : Non-ferrous metals and alloys**
**SHV: 37h30 (Class: 1h30, TP: 1h00)**
**Credits: 3**
**Coefficient:2**

**Teaching objectives:**
Lean and know the different metals apart from iron and the area of their application

**Prior knowledge:**
Physical metallurgy, extractive metallurgy

**Material content:**
1- Classification of non-ferrous metals and alloys (1 week)

2- Copper and its alloys. (2 weeks)

3- Nickel and nickel-based alloys (2 weeks)

4- Nickel and iron alloys (1 week)

5- Alloys based on Ni-Cr and Ni-Cr-Fe. (2 weeks)

6- Cobalt and cobalt alloys (1 week)

7- Aluminum and its alloys. (2 weeks)

8- Titanium and its alloys (2 weeks)

9- Anti-friction alloys. ( 1 week)

10- Metal alloys that are difficult to fuse. (1 week)

**Evaluation method:**
Continuous evaluation: 40%; Exam: 60%

**References:**
1- Métaux et alliages non ferreux. Said Bensaada. 2010. Broché
2- Alliages non ferreux. Rameau. 2015

**Semester: 3**
**Methodological teaching unit: MTU2.1**
**Matter 2: Metal forming**
**SHV: 45h00 (Courses: 1h30, PW:1h00)**
**Credits: 4**
**Coefficient: 2**

**Teaching objectives:**

In this subject, concepts and different methods of metals forming are given. The teaching of this subject will allow the student to choose in the future an adequate method of shaping for any metal.

**Prior knowledge:**

Mathematics, chemistry, solid state mechanics.

**Content :**

**I- Metal forming from liquid state** (4 weeks)

- Melting
- Solidification
- Special foundry techniques (infiltration, impregnation, oriented solidification)
- Shaping of special alloys

**II- Solid state forming metals** (5 weeks)

- Cold forming, cold plastic deformation
- Cold forming techniques, rolling, layer rolling, stamping, etc.
- Hot forming, hot plastic deformation, hot rolling, forging, extrusion, plating….

**III- Shaping of pulverized metals** (3 weeks)

- Specificities of powder shaping
- Cold forming in a closed die, cold isostatic compression, powder extrusion, etc.
- Hot forming, sintering, compression, extrusion, etc.
- Powder projection, special techniques: explosion, isostatic compression, etc

**IV- Complex shaping techniques** (3 weeks)

-Associations of shaping modes: Sintering – rolling, sintering – welding, sintering – forging, Sintering – molding (liquid phase projection),

**Evaluation method:**

- Continuous assessment: 40%; Examination: 60%.

**References**

1- Mise en forme des métaux. Eric Felder. 2017. Ellipse
2- Mise en forme des alliages métalliques à l'état semi-solide. Suery Michel. Lavoisier.

**Semester: 3**
**Discovery Teaching Unit: UED2.1**
**Subject 1: Elective Course**
**SHV: 22 hours 30 minutes (Lecture: 1 hour 30 minutes)**
**Credits: 1**
**Coefficient: 1**

**Semester: 3**
**Teaching unit: UED 2.1**
**Subject 2: Elective Course**
**SHV: 22 hours and 30 minutes (Lecture: 1 hour 30 minutes)**
**Credits: 1**
**Coefficient: 1**

**Semester: 3**
**Transversal Teaching Unit:TTU 2.1**
**Subject 1: Research Documentation and Thesis Design**
**SHV: 22 hours and 30 minutes (Lecture: 1 hour 30 minutes)**
**Credits: 1**
**Coefficient: 1**

**Objectives of the course:**

To equip the student with the necessary tools for conducting effective information research and utilizing it efficiently for their final project. To guide through the various steps involved in crafting a scientific document. Emphasizing the significance of communication and teaching how to present work rigorously and pedagogically.

**Recommended prerequisite knowledge:**

Writing methodology, Presentation methodology.

**Course content:**

**Part I: Information Research:**

**Chapter I-1: Defining the Subject (2 Weeks)**

1. Subject Title
2. List of keywords related to the subject
3. Gathering basic information (acquiring specialized vocabulary, understanding terms, linguistic definitions)
4. Desired information
5. Assessing one's knowledge in the field

**Chapter I-2: Selecting Information Sources (2 Weeks)**

1. Types of documents (Books, Theses, Dissertations, Journal Articles, Conference Proceedings, Audiovisual Material...)
2. Types of resources (Libraries, Internet...)
3. Evaluating the quality and relevance of information sources

**Chapter I-3: Locating Documents (1 Week)**

1. Research techniques
2. Search operators

**Chapter I-4: Processing Information (2 Weeks)**

1. Organizing work
2. Initial questions
3. Summarizing chosen documents
4. Connections between different sections
5. Final plan for the information research

**Chapter I-5: Bibliography Presentation (1 Week)**

1. Bibliography presentation systems (Harvard system, Vancouver system, Mixed system...)
2. Document presentation.
3. Source citation

**Part II: Thesis Development**

**Chapter II-1: Structure and Steps of the Thesis** **(2 Weeks)**

1. Define and delimit the subject (Summary)
2. Problem statement and objectives of the thesis
3. Other relevant sections (Acknowledgments, List of Abbreviations...)
4. Introduction (Writing the introduction last)
5. Review of specialized literature
6. Formulation of hypotheses
7. Methodology
8. Results
9. Discussion
10. Recommendations
11. Conclusion and perspectives
12. Table of contents
13. Bibliography
14. Appendices

**Chapter II-2: Writing Techniques and Standards** **(2 Weeks)**

1. Formatting: Numbering of chapters, figures, and tables.
2. Cover page
3. Typography and punctuation
4. Writing style, grammar, syntax in scientific language
5. Spelling: Improving general language skills in terms of understanding and expression.
6. Saving, securing, and archiving data.

**Chapter II-3: Workshop: Critical Study of a Manuscript** **(1 Week)**

**Chapter II-4: Oral Presentations and Defenses** **(1 Week)**

1. How to present a poster
2. How to deliver an oral presentation
3. Defending a thesis

**Chapter II-5: How to Avoid Plagiarism?** **(1 Week)**

1. (Formulas, sentences, illustrations, graphs, data, statistics...)
2. Citation
3. Paraphrasing
4. Providing complete bibliographic references

## Evaluation Method:

Exam: 100%

## Bibliography References:


1. *M. Griselin et al., Guide de la communication écrite, 2e édition, Dunod, 1999.*
2. *J.L. Lebrun, Guide pratique de rédaction scientifique : comment écrire pour le lecteur scientifique international, Les Ulis, EDP Sciences, 2007.*
3. *A.Mallender Tanner, ABC de la rédaction technique : modes d'emploi, notices d'utilisation, aides en ligne, Dunod, 2002.*
4. *M. Greuter, Bien rédiger son mémoire ou son rapport de stage, L'Etudiant, 2007.*
5. *M. Boeglin, lire et rédiger à la fac. Du chaos des idées au texte structuré. L'Etudiant, 2005.*
6. *M. Beaud, l'art de la thèse, Editions Casbah, 1999.*
7. *M. Beaud, l'art de la thèse, La découverte*