

**SYLLABUS – AMASE**

EUROPEAN SCHOOL OF MATERIALS SCIENCE AND ENGINEERING



### Sommaire

EEIGM skills framework

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| --- | --- | --- | --- |
|  | **GENERIC SKILLS** | **Descriptors**  **(examples of skills to identify)** | EEIGM  code |
| **DEVELOPING KNOWLEGDE** | Learning to learn | Collecting and organising knowledge | C1 |
| Analysing and synthesising knowledge |
| Assimilating new concepts quickly and easily |
| Reasoning and developing critical thinking |
| Developing new knowledge |
| **SOLVING MULTIDISCIPLINARY PROBLEMS**  **(PROFESSIONAL SKILLS I)** | Formulating and analysing complex problems | Thinking of a problem as a whole and acknowledging its multidisciplinary dimensions | C2 |
| Knowing how to simplify and outline a complex problem |
| Knowing how to proceed by analogy in order to identify a problem |
| Modelling appropriately a problem |
| Identifying the parameters to take into account |
| Adopting an applied scientific approach | Identifying the current state of knowledge in a given problem | C3 |
| Indicating possible ways of resolution |
| Establishing selection criteria from possible solutions |
| Designing and operating an experimental or simulation device and interpreting the results |
| Assessing and selecting the optimal solution in a global context |
| Innovating | Designing original solutions | C4 |
| Showing initiative and creativity |
| Thinking the problem beyond its limits |
| Rejecting norms and constraints when appropriate |
| Implementing solutions | Mastering and choosing the most appropriate methodology and technology | C5 |
| Mastering mathematical, technological and experimental tools |
| Acting in concrete terms in order to put theory into practice |
| Validating or criticising performances in relation to objectives |
| **MANAGING PROJECTS**  **(PROFESSIONAL SKILLS II)** | Planning and completing engineering projects | Defining and decomposing a project | C6 |
| Determining deadlines and deliverables |
| Evaluating the necessary and available resources |
| Identifying the different participants in a project and coordinating their action |
| Leading a project following strict specifications and constraints |
| Identifying, anticipating and managing risks and uncertainties in order to react and adapt to new situations |
| **MASTERING COMMUNICATION AND RELATIONSHIPS** | Using scientific and technological communication appropriate to the task | Communicating in several languages | C7 |
| Using clear and rigorous language |
| Preparing high-quality and clear documents, and giving well-produced presentations, adapted to the target audience |
| Organising arguments in a logical and coherent manner |
| Teamwork and leadership in professional projects | Interpersonal communication skills in different contexts –different culture, hierarchy relationships, conflict situations | C8 |
| Chairing a meeting, leading a group |
| Identifying, assessing and optimizing co-workers’ skills |
| Motivating a team |
| Behaving responsibly, being attentive to co-workers |

A competence is a **dynamic combination** of various related skills

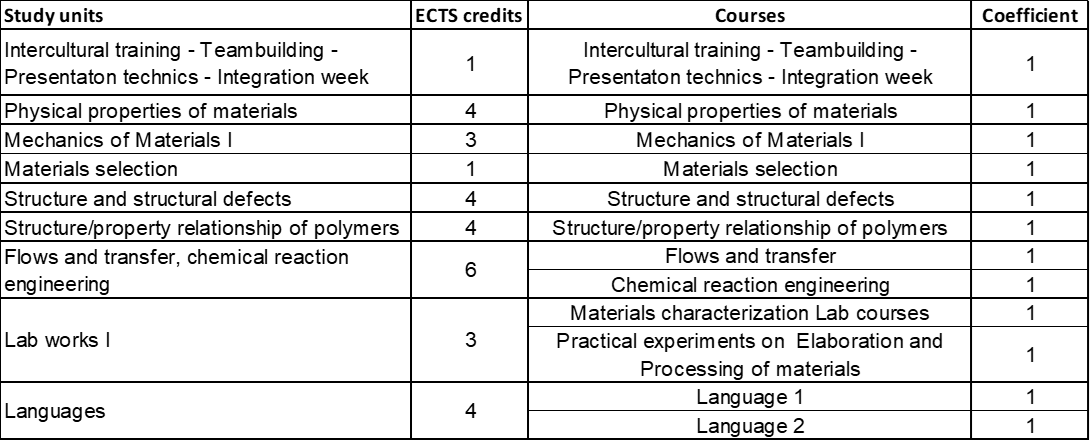
* knowledge (declarative knowledge)
* cognitive and metacognitive skills (know-how-to-learn)
* technical and methodological skills (know-how)
* interpersonal and intellectual skills (know-how-to-be)

that enables a person to act effectively in a given professional situation (know-how-to-act)

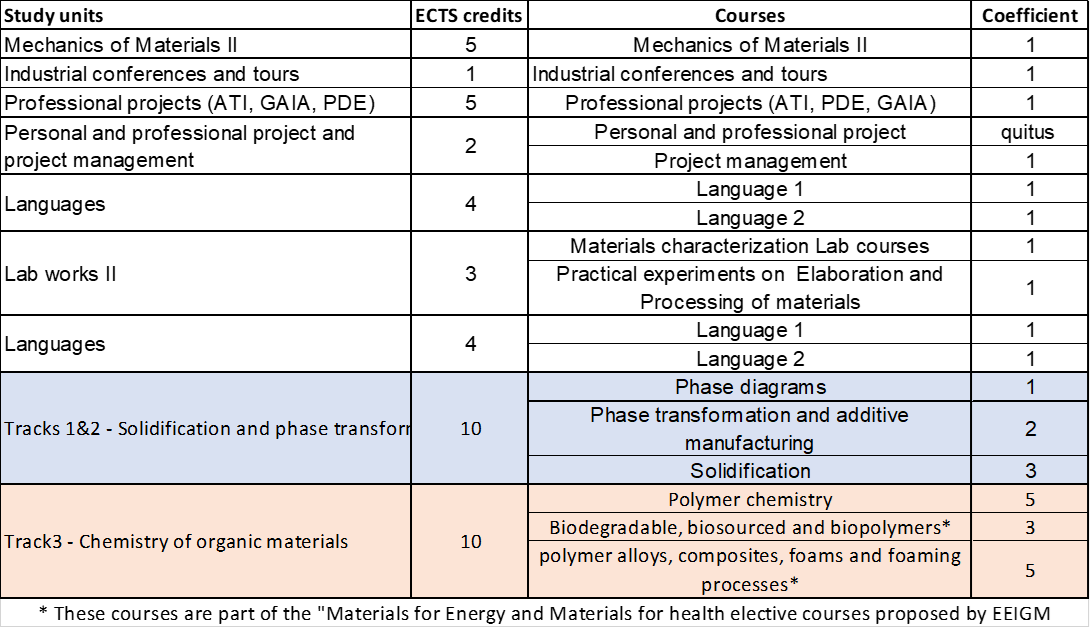
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| **SPECIFIC SKILLS (CTI 2016)** | EEIGM  Code |
| Designing or choosing a material according to a specification based on a systemic analysis of the life cycle and an assessment of costs. | CS1 |
| Mastering the processes of elaboration, transformation, treatment (thermal or surface treatment) and processing of materials (metallic materials, polymers, glasses, ceramics and composites). | CS2 |
| Mastering the techniques of chemical, physical, microstructural and mechanical characterization of materials (laboratory investigation techniques, data acquisition techniques, methods and software tools for analysis and data processing). | CS3 |
| Understanding the chemical, physical and microstructural properties of materials at atomic, nano‐, micro‐, meso‐, and macroscopic scales and being able to link them to their functional properties | CS4 |
| Conducting and managing research and development work on innovative and sustainable alternative materials. | CS5 |
| Managing investigation, product development or industrialization projects in an international context: mastering 4 European languages, teamwork in a multicultural network | CS6 |

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| --- | --- |
|  | 1st year |
|  | [SEMESTERS 7 & 8] | |

**SEMESTER 7**

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**SEMESTER 8**



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| **Teaching Unit:** Flows and Transfers | | **Year/Semester of AMASE studies:** 1st year – semester 7 | | | | |
| **Course manager:** **Z. ACEM** | | | | |
| **EEIGM Department:** **Engineering sciences** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 31 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 14.25 | 13 |  |  | 3,75 |
| **Autonomous work:** 24 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to

- Have an expert knowledge of transfer mechanisms (convection/diffusion);

- Implementing a Dimensional Analysis (DA);

- Knowing how to get some adimensional numbers expression

- Performing a balance (mass, energy, momentum)

- Understanding a conservation equation

**Syllabus:**

Convection and diffusion phenomena

- Dimensional analysis and empirical correlations

- Balance equation

- Mass, momentum and energies balance

**Pedagogical procedures (organization, assessment, pedagogical resources):**

One knowledge test (10 minuts, coeff 1), one DA exam (1 h 30, coeff 1.5) and one final exam (2h30, coeff 2).

Lecture notes, tutorial and preparation available on ARCHE (http://arche.univ-lorraine.fr/course/view.php?id=3629).

**Student’s expected work in autonomy:**

Homework preparation for Tutorial (correction provided).

**Bibliographic references:**

Coirier J., Mécanique des milieux continus - Concepts de base, 2° cycle, Dunod

• Guyon E., Hulin J.P., Petit L., Hydrodynamique Physique, Savoirs Actuels, InterEditions/Editions du CNRS

• Padet J., Fluides en écoulement : Méthodes et Modèles, 1990, Masson

**Other EEIGM courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** Heat transfer; Mechanics | Downstream**:** CMES, GRC |

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| **Teaching Unit:** Intercultural training - Teambuilding - Presentaton technics - Integration week | | **Year/Semester of AMASE studies:** 1styear – semester 7 | | | | |
| **Course manager:** **F. Soldera** | | | | |
| **EEIGM Department:** **Engineering sciences** | | **Hours/student:** | | | | |
| **Teaching method**: Active learning | | **In-person classes:** | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  |  |  |  |  |
| **Autonomous work:** | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1**  **C2**  **C3  C4**  **C5**  **C6**  **C7**  **C8** | **SC1  SC2**  S**C3**  **SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

Gain understading on the theory of intercultural interaction

Teambuilding

Be prepared to present scientific works

Build a netwlork

**Syllabus:**

**Pedagogical procedures (organization, assessment, pedagogical resources):**

This teaching unit takes place during the AMASE integration week held at UDS. Student attend to presentations, participate to seminars

**Student’s expected work in autonomy:**

**Bibliographic references:**

**Other AMASE courses directly linked to this course:**

|  |  |
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|  | Downstream**:** Project management, Personal and professional project |

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| **Teaching Unit:** Structures and Structural Defects (SDS) | | **Year/Semester of EEIGM studies: 1st year** – semester 7 | | | | |
| **Course manager:** **S. Bruyère and D. Horwat** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 16.25 | 17.5 |  |  | 3,75 |
| **Autonomous work:** | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to convey some of the essential concepts in materials science and engineering. These concepts rely the mechanical properties (strength, ductility, toughness, etc.) to the microstructures (phases, crystallography) and their crystal defects: vacancies (0D), dislocations (1D), interfaces, surfaces, grain boundaries, twins (2D), and grains, precipitates, etc. (3D).

The student will be expected to be able to explain how the microstructures are controlled, in order to optimize the physical and mechanical properties. He will learn how to use basic concepts of strengthening mechanisms (solid solution, precipitation, grain size reduction and work hardening, etc.) in understanding the performance of engineering materials and relating it to the microstructure of materials

**Syllabus:**

Presentation of the teaching unit and educational objectives (goals)

Control the structures, their defects and their activities at the meso-micro-nano scopic level (recovery and recrystallization, etc.). Optimize the defects organization for reinforcing the metallic materials.

Explain the mechanisms involved to ensure high levels of functional properties (mechanical strength, corrosion resistance, electrical and thermal conductivity, etc.).

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Two or Three tests (In English and/or in French) are scheduled with the following levels (20 + 30 + 50)/5=X/20.

Continuous Assessment: Exams programs are cumulative: each exam addresses the program implemented since the beginning of the teaching unit until the day before the test.

**Student’s expected work in autonomy:**

This teaching unit, reliying on complex concepts of Crystal Structure and Defects, is made affordable by concrete applications, often constructed in industrial practice (domain) during the tutorials, in small groups (TDs).

**Bibliographic references:**

A. Handouts of courses and tutorials are made available to students.

B. Books available at the library (SCD) of University of Lorraine:

Kelly and G.W. Groves, Crystallography and Crystal Defects, 1970, Longman, London,

D. Hull and D.J. Bacon, Introduction to Dislocations, Third Ed., Vol. 37, 1984, Pergamon Press,

J. and Julia Weertman, Elementary Dislocation Theory, 1966, Oxford University Press,

R.W.K. Honeycombe, The plastic Deformation of Metals, Second Ed., 1984, Edward Arnold, London,

W.T. Read, Dislocations in Crystal, 1953, McGraw-Hill Book Co. New York,

C. Web sites dealing with the field of metallic materials and their crystal defects.

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** : Phase transformations, Materials Characterization, Metallic materials making process |

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| **Teaching Unit:** PHYSICAL PROPERTIES OF MATERIALS | | **Year/Semester of EEIGM studies:** 1st year – semester 7 | | | | |
| **Course manager:** **T. CZERWIEC** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 32.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 15 | 15 |  |  | 2.5 |
| **Autonomous work:** 20 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to understand the basics of the physical properties of materials (electronic, thermal and magnetic) in relation with the structure of materials.

**Syllabus:**

This module includes three parts: electrical properties, thermal properties and magnetic properties. Part 1, which is the most significant, is divided into three subsections. In the first, some theoretical concepts are presented (Drude model and quantum model of the free electron and energy bands) for introducing fundamental concepts (density of states, Fermi energy, energy bands) The concept of Brillouin zone is approached in order to enable a coupling between the electrical properties in metals and semiconductors and their crystallographic structures. The second part deals with applications to electrical conductivity in metals. The behavior of metals and metal alloys is studied as a function of temperature, and defects and of the material composition. A final section is devoted to semiconductor materials (intrinsic behavior extrinsic type of gap ...). In the third part theoretical concepts (electrostatic dielectric, polarization charges, electric dipoles, frequency responses of the dipoles ...) and applications (capacitors) are introduced The concepts of piezoelectricity, pyroelectricity and ferroelectricity are also discussed. The thermal part introduces the concepts of thermal capacity and thermal expansion coefficient through models of continuous and discontinuous areas. The concepts of Debye temperature and phonons are treated. In the last part, we introduce the notions of diamagnetism, paramagnetism and ferromagnetism through theoretical concepts (magnetostatic of magnétiuqes circles magnetic dipole moments, moments orbital kinetic and spin) and practical (hysteresis cycles).

**Pedagogical procedures (organization, assessment, pedagogical resources):**

\* Prepared handout transcribing the course in detail, available on ARCHE

\* Forward tutorials

\* The Evaluation is mainly done in a conventional manner (2 tests based on problems) with the prepared handout. During these examinations, students must answer questions on the basis of the course for 10 minutes without he prepared handout.

A bonus is awarded by student groups on the basis of written responses to questions asked at the end of certain courses.

**Student’s expected work in autonomy:**

The concepts covered in this course are difficult and a certain number have not been seen by foreign, FPA and admitted students. To fill this gap, students have access, via Arche, to the very complete documents of the IPM and APM courses delivered in the second year. Students must see or review these courses in order to best appreciate the difficult concepts addressed in PPM

**Bibliographic references:**

See the many references in the course material

**Other AMASE courses directly linked to this course:**

|  |  |
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| Upstream**:** all physics courses | Downstream**:** |

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| **Teaching Unit:** Structure / Property Relationships of Polymers | | **Year/Semester of EEIGM studies:** 1st year – semester 7 | | | | |
| **Course manager:** **I. ROYAUD** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 18.75 | 16.25 |  |  | 2.5 |
| **Autonomous work:** 30 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to understand the physical phenomena specific to polymers (eg mechanical, thermal, optical, dielectric properties, main thermal transitions in polymers such as the glass transition, notions of molecular mobility), know the different classes of polymers in terms of morphology / microstructure, understand the structure / physical properties relationships in order to be able to optimize the choice of polymer materials for a given application and use properties.

**Syllabus:**

General information on Polymers (macromolecules)

 Solid state cohesion

 Rubber elasticity

 Glass transition

 Molecular mobility (linear viscoelasticity, dynamic mechanical and dielectric properties)

 Semi-crystalline polymers: crystallization, melting, structure / property relationships. Notions on the mechanical behavior at strong deformations (plastic deformation, damage mechanisms, break).

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Educational resources: one handout on Polymers Physics

 TD: exercises from the book by Etienne S., David L., Introduction to the Physics of Polymers, 2002, Dunod

and a project by active learning

 4 additional tutoring sessions in TD (4x1h15 = 5h)

 Assessment: An intermediate test (1h15) + a final control (1h15) + an assessment by active learning

**Student’s expected work in autonomy:**

Re-read the courses, learn about the subjects covered related to polymer physics, prepare the tutorials

**Bibliographic references:**

 Etienne S. David L., Introduction to the Physics of Polymers, 2002, Dunod

 Oudet C., Polymers, Structures and Properties, Materials Sciences, 1994, Masson

 Lauprêtre F., Polymer Materials: Macroscopic Properties and Molecular Interpretations, 2011, John Wiley & Sons

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream**:** All chemistry courses | Downstream**:** |

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| **Teaching Unit:** Mechanics of Materials 1 (MM1) | | **Year/Semester of EEIGM studies:** 1st year – semester 7 | | | | |
| **Course manager:** **Z. AYADI** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 30 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 13.75 | 13.75 |  |  | 2.5 |
| **Autonomous work:** 15 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to characterize the viscoelastic behavior in statics and dynamics. Model this behavior with a view of prediction. Understand and anticipate the failure of materials (failure facies, main parameters, approach and propagation and failure criterion). To be able to use an industrial Finite Element Analysis software to study a failure problem and analyze the results (compared to the real problem, to the assumptions, ...) An inductive approach to viscoelasticity and the fracture mechanics of materials by implementing the steps: observation, experiment, results, interpretation, assumptions, modeling, comparison of predictions to reality, conclusion

**Syllabus:**

Introduction - Main rheological behaviors - Schematizations of rheological behaviors - Uniaxial linear viscoelastic behavior - Constitutive law - Creep and relaxation functions for a viscoelastic material - Experiments characteristic of viscoelastic behavior - Principle of superposition of BOLTZMANN - Use of operational computation to solve a linear viscoelasticity problem - Models for uniaxial non-aging linear viscoelastic behavior - Study of viscoelastic behavior in dynamic regime II. Introduction - Why study fracture - Approaches to fracture mechanics – Main Factors influencing fracture - Failure mechanics at different scales - Failure modes - Failure mechanics by the linear elasticity approach - Stress intensity Factor and stress concentration factor - Critical stress intensity factor - Toughness - Special case of glass fracture - Crack propagation by fatigue. This content is supported by an industrial conference on industrial applications of fracture mechanics, fracture expertise as well as an introduction to fatigue.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Students are informed during the first lecture of the organization, progress and evaluation of the module 1 : Intermediate exam and 1 Final exam, during the exam the documents, programmable calculators and cell phones are not allowed. The non respect of these instructions constitutes fraud. Teachers involved in tutorials will rotate in the different exercises groups as far as possible. Arch educational platform: The course handout (with holes) , exercises and solutions are available on this teachning plateform.

**Student’s expected work in autonomy:**

To participate in all the sequences of the module (lecture tutorials, exercises and numerical mechanics FEM) Review in the following order: understand the lecture, doing the main exercises and some other problems

**Bibliographic references:**

A list of books available in libraries is offered in the first lecture. Useful links on the arche teachning platform: other exercises, other lectures, ...

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream**:** RDM, MSD | Downstream**:** Mechanics of materials II |

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| **Teaching Unit:** Chemical Reaction Engineering | | **Year/Semester of EEIGM studies:** 1st year – semester 7 | | | | |
| **Course manager:** **M-O. SIMONNOT** | | | | |
| **EEIGM Department:** **Elaboration and processing of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 35 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 15 | 16.25 |  |  | 3.75 |
| **Autonomous work:** 35 or more | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to 1) establish material and energy balances in closed or open systems in which a chemical reaction takes place, 2) choose a type of reactor for a given objective and to dimension ideal chemical reactors in transient (closed, semi-closed) or permanent (continuous reactors) regimes, 3) study the hydrodynamics of the reactors by the method of the distribution of residence times and to represent non-ideal reactors (in simple cases) by assembling ideal reactors.

**Syllabus:**

Presentation of the module and its situation in the EEIGM curriculum and the Process (Chemical) Engineering discipline

Material balance in the presence of a chemical reaction (macroscopic or differential/closed or open, transient or permanent system). Reminder of the basics of kinetics and chemical thermodynamics.

Design of ideal simple reactors and then in combination (series/parallel).

Energy balance in ideal chemical reactors. Isothermal and adiabatic reactors.

Measurement of hydrodynamics by the residence time distribution method.

Modeling concepts of real reactors by association of ideal reactors, cascade mixer model.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Organisation: lectures, tutorials (in groups) (lectures can be given in English but in recent years they have been given in French, according to the choice of the students).

Assessment: 1 homework assignment (coeff. 0.5), 1 intermediate test (1.25 h - coeff. 1.5) and a final test (2.5 h - coeff. 3).

Teaching resources: course and TD handouts written in English, course slide presentations, support documents (mathematical reminders, examples, corrections of TDs and old tests, website addresses) available on the Arche digital platform. Books in the library.

**Student’s expected work in autonomy:**

Absolute necessity of regular work (at the very rhythm of the classes and tutorials) to master the content of the courses, to study the examples, to prepare the exercises, to redo them, possibly to do others.

**Bibliographic references:**

Fogler HS, Elements of Chemical Engineering; Prentice Hall, 1992

Villermaux J., Génie de la Réaction Chimique 1993, Lavoisier Tec et Doc

Techniques de l'ingénieur

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** mathematics courses | Downstream**:** polymerization engineering, flows and transfers, separation engineering, process engineering, internships, projects |

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| **Teaching Unit:** Phase Diagrams | | **Year/Semester of EEIGM studies:** 1st year – semester 8 | | | | |
| **Course manager:** **J. Zollinger** | | | | |
| **EEIGM Department: Elaboration and processing of materials** | | **Hours/student:** | | | | |
| **Teaching method:** Academic | | **In-person classes:** 16.25 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 7.5 | 7.5 |  |  | 1.25 |
| **Autonomous work:** 17.5 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to demonstrate and use the main mathematical expressions at the basis of phase transformation thermodynamics. The student will also be able to understand and use the origins of binary and ternary phase diagrams.

**Syllabus:**

Useful thermodynamics data. Stable, metastable and unstable equilibriums and conditions of transformations

Binary and ternary phase diagrams (origin and use)

**Pedagogical procedures (organization, assessment, pedagogical resources):**

1 written evaluations of 75 minutes. Duplicated lecture notes are provided. Slides and demonstrations can contain additional informations to the lecture notes.

**Student’s expected work in autonomy:**

Preparation of some lectures by reading in advance the duplicated lecture notes and preparing questions for reversed pedagogy.

**Bibliographic references:**

Phase transformations in metal and alloys (Porter et Easterling)

Précis de métallurgie

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** Structures and structural defects | Downstream**:** Materials Characterization, Phase transformations II : kinetics, assembly and aditive manufacturing |

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| **Teaching Unit:** PROJECT MANAGEMENT | | **Year/Semester of EEIGM studies:** 1st year – semester 8 | | | | |
| **Course manager:** **R. ALTMEYER** | | | | |
| **EEIGM Department:** **Development and research** | | **Hours/student:** | | | | |
| **Teaching method**: Active Learning | | **In-person classes:** 3.75 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Competencies approach | | 2.5 | 1.25 |  |  |  |
| **Autonomous work:** 20 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to

• adopt a common language as well as a project management terminology

• use the basic principles and tools in project management

• to use this knowledge and to act independently within the framework of the 3rd Year Professional projects

**Syllabus:**

Objectives targeted within the discipline:

• Broaden the base of knowledge related to the engineering tasks

• Know the process of managing a project of any kind (industrial / associative / staff)

• Present the theoretical instruments for the development, management and evaluation of projects from an interdisciplinary perspective

**Pedagogical procedures (organization, assessment, pedagogical resources):**

2 lectures of 1h15 to give the keys to project management, to be applied in professional projects, 1 tutorial to take stock of the organization adopted in professional projects, 1 defense of 15-20 min to explain this organization at the end of the semester and 1 report at the end of the year

• Documentary resources: Copy of the projected PowerPoint available on ARCHE

**Student’s expected work in autonomy:**

**Bibliographic references:**

L'analyse des besoins : la gestion de projet par étapes / Hugues Marchat, Éd. d'Organisation, 2006

• Comment manager un projet / Jean-Jacques Néré, Demos, 2000

• Les compétences pour gérer un projet : des fiches de fonctions / Jean Le Bissonnais, AFNOR, 2003

• Conduire un projet à l'usage des PME, PMI, TPE et des collectivités territoriales / Roger Aïm, Afnor, 2009

• Conduire un projet d'organisation : guide méthodologique : les 3 étapes de la démarche générale, les 15 outils de pilotage, les 7 compétences relationnelles, les 10 thèmes classiques, les 5 méthodes spécifiques, les 46 outils techniques / Henri-Pierre Maders, Elizabeth Gauthier, Cyrille Le Gallais, Éd. d'Organisation, 1998

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** Professional project |

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| **Teaching Unit:** Materials Selection in Mechanical Design | | **Year/Semester of EEIGM studies:** 1st year – semester 7 | | | | |
| **Course manager:** **S. BRUYERE** | | | | |
| **EEIGM Department:** **Development and research** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 7.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Competencies approach | | 6.25 | 1.25 |  |  |  |
| **Autonomous work:** 3 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should know how to select materials in mechanical design. This teaching unit provid insights and understanding of the engineering factors to be considered in selecting and justifying materials for new or replacement applications. It creates an awareness of many other factors that enter into engineering decisions, including cost, eco conception, …

**Syllabus:**

This module describes the procedure for the selection of materials based on their intrinsic or technical properties, their functions, their shapes, processes for their implementation, their life-cycle, their costs. The optimization of these parameters is part of the design criteria. This task, in principle very tedious, is facilitated by the development in the market for databases and software selection assistance.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Courses handouts (6.25h) and Tutorials (1.25h) (in French and English for familiarization of technical vocabulary of Material selection in mechanical design) - Case studies in which the method is applied to material selection.

Assessment with a multiple-choice questionnaire and a case study.

**Student’s expected work in autonomy:**

The class will be divided into teams consisting of no less than 3 (and no larger than 5) students who will work together on a Design project.

**Bibliographic references:**

ASHBY, M F. 'Materials Selection and Process in Mechanical Design.' Butterworth Heinemann, Oxford, 1999 ISBN 0-7506-4357-9

ASHBY, M.F. and CEBON. D. 'Case studies in Materials Selection.' First Edition, Granta Design, Cambridge, 1996, Second Edition, Butterworth-Heinemann, Oxford, 1999

Le logiciel CES Materials Selection, developpé par M. Ashby, est disponibles sur les ordinateurs personnels des élèves et sur ceux des salles informatiques de l'Ecole (EEIGM)

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream**:** Physical properties of materials, Polymer physics, structures and structural defectsMechanics of materials | Downstream**:** |

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| --- | --- | --- | --- | --- | --- | --- |
| **Teaching Unit:** Industrial conferences and tours | | **Year/Semester of EEIGM studies:** 1st year – semester 8 | | | | |
| **Course manager:** **Z. AYADI and J. ZOLLINGER** | | | | |
| **EEIGM Department:**  **Development and research** | | **Hours/student:** | | | | |
| **Teaching method**: Active Learning | | **In-person classes:** 4,17 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** | | 4.17 |  |  |  |  |
| **Autonomous work:** | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2  C3  C4  C5**  **C6 C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

Completing the training and bringing a different lignt by professionals. Narrow contact between students and profesionnals. Participation of the companies and the socio-economic environment in the training.

They also constitute an important opportunity to take advantage of internship or job offers and make the link between the courses at EEIGM and the industrial needs in materials engineering.

**Syllabus:**

**Pedagogical procedures (organization, assessment, pedagogical resources):**

The conferences are usually scheduled on Wednesdays from 11h15 to 12h30. It is mandatory for the students to attend the conferences by which they are concerned. The tours are scheduled on Thursdays afternoon:

– 20 to 30 seats / tour

– Registration on Arche

Before the tour:

• Preparation of tour (informations about the company)

• Setting up thematic groups

After the tour :

• Report

**Student’s expected work in autonomy:**

• Parts of the report

– presentation of the company: products, strategy, technology, etc.

– Work done by the engineers in this company ?

– Health and safety

– Input of EEIGM skills

**Bibliographic references:**

Arche: Direction of partnerships

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** |

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| **Teaching Unit:** French as a Foreign Language V | | **Year/Semester of AMASE studies:** 1st year – semester 7 | | | | |
| **Course manager:** **K. HENRY** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 37.5 |  |  |  |
| **Autonomous work:** 6 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to communicate in most situations of daily life, will know the grammatical structures and the basic lexicon (for groups of level A1, A2 or B1). The student in a group of level B1.2 or B2 will be able to communicate on a fairly wide range of subjects with a good grammatical control and good command of the lexicon. He can give his opinion, start arguing, explain and clarify his words. The student, whatever his level, will also know the cultural environment better in which he lives and studies.

**Syllabus:**

Activities in the 4 skills (oral comprehension, written comprehension, oral expression and written expression) adapted to the group level, according to the objectives set by the CEFR. Priority is given to the oral. Grammar and lexical strengthening activities. Activities of discovery / strengthening of knowledge of French civilization and culture. Phonetics activities.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Assessment based on attendance, class participation, personal work provided, progression and a final test.

The materials used in class are authentic documents as well as extracts from the Internet or methods.

**Student’s expected work in autonomy:**

Complementary exercises on handouts or on the internet; written production exercises; preparation of presentations.

**Bibliographic references:**

French websites for information or learning French; Collections of books to study French as a foreign language from the publishing houses "Clé international", "Didier", Hachette, Presses universitaires de Grenoble (PUG)

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** French as a foreign language VI |

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| **Teaching Unit:** English V 15 | | **Year/Semester of AMASE studies:** 1st year – semester 7 | | | | |
| **Course manager:** **N. BRIE** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 15 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 15 |  |  |  |
| **Autonomous work:** 2 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should have a sufficient level in English to prepare for his/her international mobility; teaching contents and methods are adapted to the level of each group.

**Syllabus:**

Students who have done their first two years at EEIGM: 16,25 hours in the first semester: consolidation of acquired skills, practising oral expression, notions of technical, professional and scientific English. Communication class: personality test, body language, class-assessing Powerpoint presentations

**Pedagogical procedures (organization, assessment, pedagogical resources):**

"Authentic" documents (written, audio, video), scientific articles, on-line documents

**Student’s expected work in autonomy:**

Use of the resources of the Foreign Language Learning Center

**Bibliographic references:**

Defined for each group at the beginning of the year

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** VI |

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| **Teaching Unit:** English V 26.25 | | **Year/Semester of AMASE studies:** 1st year – semester 7 | | | | |
| **Course manager:** **N.BRIE** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 26.25 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 26.25 |  |  |  |
| **Autonomous work:** 10 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should have a sufficient level in English to prepare for his/her international mobility; teaching contents and methods are adapted to the level of each group.

**Syllabus:**

New students (below B2 level): one group (A2/B1 level) will follow a 30-hour course to update and consolidate their knowledge and skills in view to prepare for FCE in 4th year. 2 other groups (B2/C1 and C1/C2 levels) will follow a 30-hour course to update and consolidate their knowledge and skills in view to prepare for FCE, CAE or CPE in the 2nd semester of the 3rd year

**Pedagogical procedures (organization, assessment, pedagogical resources):**

FCE/CAE/CPE past exams and practice tests

Continuous assessment: oral and written tests

"Authentic" documents (written, audio, video), on-line documents

**Student’s expected work in autonomy:**

Use of the resources of the Foreign Language Learning Center

**Bibliographic references:**

Defined for each group at the beginning of the year

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** VI |

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| **Teaching Unit:** SPANISH 5 BEGINNERS | | **Year/Semester of AMASE studies:** 1st year – semester 7 | | | | |
| **Course manager:** **C. SAVARD-CHAMBARD** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 37.5 |  |  |  |
| **Autonomous work:** 3 h per week | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should have acquired basic notions to understand and be understood in situations of everyday life. Levels to achieve A2 to B1 (self-assessment grid European Framework

**Syllabus:**

Acquisition of basic knowledge and skills necessary to understand and express oneself both orally and writing

**Pedagogical procedures (organization, assessment, pedagogical resources):**

ELE method and tuition in small groups (maximum 18 students)

Continuous assessment: evaluation of the 5 language skills

Studies of Spanish press articles and use of texts and audio recordings available on the Cervantes Institute web-site

**Student’s expected work in autonomy:**

Assimilation of knowledge and expertise

Prepare oral presentations on everyday life topics

Use of the resources of the library and language lab

**Bibliographic references:**

Class workbook: Campus Sur A1-A2 Libro del alumno y Cuaderno de ejercicios, Difusión, 2019

Grammar book: Competencia gramatical en uso, Nivel A2, Edelsa, Madrid, 2008

Bilingual dictionary Larousse

Vocabulary book: Maribel Molio, 60 fiches de vocabulaire espagnol, Studyrama, Paris, 2012

Conjugation book: Bescherelle, El arte de conjugar en español

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** Spanish 6 |

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| **Teaching Unit:** Spanish 5 LV2 or LV3 | | **Year/Semester of AMASE studies:** 1st year – semester 7 | | | | |
| **Course manager:** **C. SAVARD-CHAMBARD** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 18.75 h B2 level and higher  26.25 h A2, B1 levels and Prepa DELE LV2-LV3 |  |  |  |
| **Autonomous work:** 3 h per week | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to depending on the groups, prepare for the Spanish DELE examination (B2, C1 or C2 levels) or reason by oneself on current topics, personal or professional interest

**Syllabus:**

For students preparing the DELE: training written and oral tests

For other students: consolidation and enrichment of knowledge and skills on current topics and professional issues

**Pedagogical procedures (organization, assessment, pedagogical resources):**

ELE method and tuition in small groups (maximum 18 students)

Continuous assessment: past DELE examinations B2 level + 2 DELE mock exams

Continuous assessment: evaluation of the 5 language skills

Past DELE examinations

Class workbooks: 1/ and 2/ Al dí@: curso intermedio de español para los negocios, Libro del alumno y Cua-derno de ejercicios, SGEL, Madrid, 2010

**Student’s expected work in autonomy:**

Assimilation of knowledge and expertise

Training past DELE examinations

Prepare oral presentations on social or current topics

Use of the resources of the library and language lab

**Bibliographic references:**

Workbooks: 1/ 1/ Las claves del nuevo C1, Difusión, 2016; 2/ C de C1. Curso de español de nivel superior, Difusión, 2019; 3/ Preparación al Diploma de Español, Nivel B2, Edelsa, 2018

Grammar books: 1/ Las 500 dudas más frecuentes del español, Espasa Calpe, 2019; 2/ Competencia gramati-cal en uso Nivel B2, Edelsa, Madrid, 2014

Dictionaries: 1/ Le vocabulaire de l'espagnol, Hachette, Paris, 2010; 2/ Diccionario de la lengua española, Real Academia Española, Madrid, 2012

Vocabulary book: 100 fiches de vocabulaire espagnol, Studyrama, Paris, 2010

Conjugation book: Bescherelle, El arte de conjugar en español

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** Spanish 6 |

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| **Teaching Unit:** German V 38 | | **Year/Semester of AMASE studies:** 1st year – semester 7 | | | | |
| **Course manager:** **H. Köhler-Betous** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 37.5 |  |  |  |
| **Autonomous work:** 10 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to practice German with the objective of reaching the level A1 ("Basic User") of the Common European Framework of Reference for Languages (CEFR).

**Syllabus:**

Introduction to the German language.

Training reception ("listening" and reading"), production ("speaking" and "writing") as well as interaction ("taking part in a discussion").

Introduction to the realities of the German speaking world.

Preparation for and help in finding the stay in a German speaking country.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Continuous assessment.

Use of course books, original documents and on-line resources.

**Student’s expected work in autonomy:**

Diverse application exercises, including reception and production.

**Bibliographic references:**

"Menschen A1", Hueber

"Studio [21] A1", Cornelsen

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** German VI 38 |

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| **Teaching Unit:** German V 26 | | **Year/Semester of EEIGM studies:** 1st year – semester 7 | | | | |
| **Course manager:** **H. Köhler-Betous** | | | | |
| **EEIGM Department: European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 26.25 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 26.25 |  |  |  |
| **Autonomous work:** 5 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to practice German with the objective of reaching the level A2 ("Basic User") of the Common European Framework of Reference for Languages (CEFR).

**Syllabus:**

Consolidation and enrichment of the language.

Training reception ("listening" and reading"), production ("speaking" and "writing") as well as interaction ("taking part in a discussion").

Introduction to the realities of the German speaking world.

Preparation for and help in finding the stay in a German speaking country.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Continuous assessment.

Use of course books, original documents and on-line resources.

**Student’s expected work in autonomy:**

Diverse application exercises, including reception and production.

**Bibliographic references:**

"Menschen A2", Hueber

"Studio A2", Cornelsen

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** German VI 28 |

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| **Teaching Unit:** German V 19 | | **Year/Semester of AMASE studies:** 1st year – semester 7 | | | | |
| **Course manager:** **H. Köhler-Betous** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 18.75 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 18.75 |  |  |  |
| **Autonomous work:** 5 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to pass the Zertifikat Deutsch (ZD), an internationally recognized exam of German language ability (CEFRL levels B1+, B2, C1, C2).

**Syllabus:**

Consolidation and enrichment of the language.

Training reception ("listening" and reading"), production ("speaking" and "writing") as well as interaction ("taking part in a discussion").

In-depth knowledge of the realities of the German speaking countries.

Preparation for the Zertifikat Deutsch (ZD).

Preparation for and help in finding the stay in a German speaking country.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Working in groups according to the level.

Continuous assessment.

Mock exam (approx. additional 3,5h/student).

Use of course books, original documents and on-line resources.

**Student’s expected work in autonomy:**

Diverse application exercises, including reception and production.

**Bibliographic references:**

https://www.goethe.de/de/spr/kup/prf/prf.html

https://www.dw.com/de/deutsch-lernen/lernangebote-f%C3%BCr-das-niveau-b2/s-13217

"Fit fürs Zertifikat Deutsch", Hueber

"Mit Erfolg zum Zertifikat Deutsch", Klett

"Prüfungstraining DaF", Cornelsen

"Sicher!", Hueber

"Werkstatt", Praxis

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** German VI 16 |

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| **Teaching Unit:** Mechanics of Materials 2 (MM2) | | **Year/Semester of AMASE studies:** 1st year – semester 8 | | | | |
| **Course manager:** **Z. AYADI** | | | | |
| **EEIGM Department: Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 30 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 13,75 | 13,75 |  |  | 2.5 |
| **Autonomous work:** 15 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should have acquired the basic knowledge to understand, analyze and solve a plasticity problem in order to predict the consequences on the process of shaping materials. Define the appropriate stress and strain measurements, the characteristic experiments, the information to be analysed, the parameters on which t the material behavior depend, the necessary elements to build an elastoplastic behavior law with hardening. To be able to use an industrial Finite Element Analysis software to study plasticity problem (compared to the real problem, to the assumptions,...). An inductive approach to plasticity in material mechanics by implementing the steps: observation, experiment, results, interpretation, assumptions, modeling, comparison of predictions with reality, conclusion

**Syllabus:**

Introduction of Mechanics of Continuous Media tools for the study of plasticity - implementation of the measurement of suitable strain tensor for plasticity - Large deformations - introduction of the measurement of stress tensor adapted to plasticity - Main mechanical tests - Experimental characterization of plasticity (Information to be used from the experiment, yield stress, hardening, ...) - Main parameters affecting the elastoplastic behavior - Criteria of plasticity - Load function - Example of construction of elastoplastic constitutive law - determination of the constitutive law parameters - Particular case of the plasticity of the beams.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Students are informed during the first lecture of the organization, progress and evaluation of the module 1 : Intermediate exam and 1 Final exam, during the exam the documents, programmable calculators and cell phones are not allowed. The non respect of these instructions constitutes fraud. Teachers involved in tutorials will rotate in the different exercises groups as far as possible. Arch educational platform: The course handout (with holes), exercises and solutions are available on this teaching platform.

**Student’s expected work in autonomy:**

To participate in all the sequences of the module (lecture tutorials, exercises and numerical mechanics FEM) Review in the following order: understand the lecture, doing the main exercises and some other problems

**Bibliographic references:**

A list of books available in libraries is offered in the first lecture. Useful links on the arche teachning platform: other exercises, other lectures, ...

**Other AMASE courses directly linked to this course:**

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| Upstream**:** RDM, MSD, MM1 | Downstream**:** MM3,SDS |

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| **Teaching Unit:** Materials Characterization Lab Courses | | **Year/Semester of AMASE studies:** 1st year - semesters 7&8 | | | | |
| **Course manager:** **J. ZOLLINGER** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 28 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  |  | 28 |  | 1.25 |
| **Autonomous work:**8 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should know the basic materials characterization techniques, ranging from physical principle to their potential applications.

**Syllabus:**

This lab course revolves around 8 stations, each dedicated to a technique: mechanical (tensile test, hardness, charpy), thermal (DSC, Dilatometry), structural (X-ray diffraction, Raman spectrometry, crystallization), chemical (SEM-EDS) will be discussed, each time for the different classes of materials such as polymers, ceramics and metals.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

The practical work takes place over 3h30 slots, and students are invited to prepare for the work in advance by reading the documents available. This practical work will be assessed by a final test of 1h15. For each practical work, documentation is made available on the Arche page of the course and available in the practical work room.

**Student’s expected work in autonomy:**

Preparation of sessions (reading of the subject and associated documents) and preparation of reports of the sessions in order to keep track of the work carried out to better prepare the final test.

**Bibliographic references:**

Cahn, R. W., Kramer, E. J., Lifshin, E., & Haasen, P. (Eds.). (1994). Characterization of Materials: Part II. VCH.

Documents available on the course site.

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** All materials courses | Downstream**:** 4Y Materials Projects |

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| **Teaching Unit:** Polymer Chemistry | | **Year/Semester of AMASE studies:** 1st year – semester 8 | | | | |
| **Course manager:** **J-L. SIX** | | | | |
| **EEIGM Department:** **Elaboration and processing of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 18.75 | 16.25 |  |  | 2.5 |
| **Autonomous work:** 28 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to understand the differences between chain polymerizations (radical and ionics) and step polymerizations (polycondensation). He/she will know chemical, thermodynamical and kinetics aspects of all poylmerization techniques and would be able to list the advantages/drawbacks of each technique to obtain desired polymer.

**Syllabus:**

This teaching unit will be divided into 6 parts and illustrated during lectures and tutorial classes:

- Generalities

- Radical Polymerization

- Copolymerizations

- Ionic Polymerizations

- Stereospecific Polymerizations

-Polycondensations (step-polymerizations)

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Pedagogical Resources: 1 handout

Assessment : 2 tests (1h15 each test)

The final mark will be the average of these two tests

**Student’s expected work in autonomy:**

At regular intervals, student has to review and learn lectures and tutorials to avoid the confusion between each polymerization techniques that are characteristic with particular kinetics and issues

**Bibliographic references:**

Hamaide T., Fontaine L., Six JL., Chimie des Polymères. Exercices et Problèmes corrigés 2nde édition, 2014, Lavoisier

Fontanille M., Gnanou Y., Chimie et physico-chimie des polymères 3ème édition, 2014, Dunod

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** Organic chemistry I, Organic chemistry II, Chemical kinetics, , Chemical thermodynamic, Organic chemistry praticals, Organic chemistry III. | Downstream**:** Pratical Experiments on Elaboration and processing of materials, Degradation and Stabilisation of Polymers, Composite materials with polymer matrix: Synthesis, processing and properties in use, Polymer reaction engineering , Biopolymers and Biodegradable Polymers, Biomedical Applications of Polymers, Functional Polymers |

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| **Teaching Unit:** Phase transformation and additive manufacturing | | **Year/Semester of AMASE studies:** 1st year – semester 8 | | | | |
| **Course manager:** **J. ZOLLINGER** | | | | |
| **EEIGM Department:** **Elaboration and processing of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 32.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 15 | 15 |  |  | 2.5 |
| **Autonomous work:** | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to understand the kinetics of phase transformations in metallic materials and apply them to a wide range of industrial processes, including welding and additive manufacturing

**Syllabus:**

The course is divided into three parts articulated around the kinetics of phase transformations:

- Basic knowledge: nucleation & crystal growth during solidification and in solid state transformations, kinetic modifications of the phase diagram

- Assembly: kinetic aspects of brazing and welding

- Additive manufacturing: out-of-equilibrium phenomena, selection of microstructures

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Organization: Lectures and Tutorials

Resources: 1 course handout, course transparencies, 1 tutorial handout.

Evaluations: Two 1h15 tests.

**Student’s expected work in autonomy:**

Reading of course documents, preparation of tutorials, reading of bibliographic references.

**Bibliographic references:**

Porter, D. A., Easterling, K. E., & Sherif, M. (2009). Phase transformations in metals and alloys (Revised Reprint). CRC press.

Kurz, W., & Fisher, D. J. (1989). Fundamentals of solidification.

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** Structures and structural defects, Phase diagrams | Downstream**:** Practicals of Preparation and processing of materials, Metallic Materials Projects. |

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| **Teaching Unit:** Practical Experiments on Elaboration and Processing of materials | | **Year/Semester of EEIGM studies:** 1st year – semesters 7&8 | | | | |
| **Course manager:** **J-L. SIX** | | | | |
| **EEIGM Department:** **Elaboration and processing of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 21 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  |  | 21 |  | 1.25 |
| **Autonomous work:** 6 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should understand the elaboration of metallic and polymeric materials using various industrial processes and the physical-chemistry of these materials.

**Syllabus:**

These practical experiments will be done during the third year of EEIGM. There will be:

A) 4 experiments on Polymers Chemistry and Polymers Physico-Chemistry:

• Anionic Polymerization and Radical Suspension Polymerization

• Emulsion Radical Copolymerization

• Size Exclusion Chromatography

• Viscosimetry of Polymeric Solutions

B) 2 experiments on Metallurgy

Preparation, treatment and properties of aeronautics aluminium alloys

Secondary hardening treatments in high performances steels.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Pedagogical Resources: 1 handout "Pratical Experiments on Polymer Chemistry and Polymer Physico-Chemistry" + 1 handout "Metallurgy"

Assessment: 1 test (1h15) "Pratical Experiments on Polymer Chemistry and Polymer Physico-Chemistry" + evaluation of practical reports on "Metallurgy"

The final mark will be the weighted average of these two tests (2/3 for polymers; 1/3 for metallic materials).

**Student’s expected work in autonomy:**

With the notes taken during your practical experiments, you will remember and review

**Bibliographic references:**

Hamaide T., Fontaine L., Six JL., Chimie des Polymères. Exercices et Problèmes corrigés 2nde édition, 2014, Lavoisier

J. Barralis, G. Maeder, Précis de Métallurgie, Élaboration, structures-propriétés, normalisation, Edition 2005, Précis-Afnor Nathan

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** Polymer Chemistry, Structure and structural defects, Phase transformations…. | Downstream**:** Degradation and Stabilisation of Polymers, Composite materials with polymer matrix: Synthesis, processing and properties in use, Functional Polymers, Metallic Materials Projects…. |

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| **Teaching Unit:** PROFESSIONAL PROJECT (ATI, GAIA, PDE) | | **Year/Semester of AMASE studies:** 1st year - semester 8 | | | | |
| **Course manager:** **V. VITZTHUM** | | | | |
| **EEIGM Department:** **Development and research** | | **Hours/student:** | | | | |
| **Teaching method**: Active Learning | | **In-person classes:** 75 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Competencies approach | |  |  |  | 75 |  |
| **Autonomous work:** 75 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to immerse him/herself in a completely new project problem, manage a project and play an expert role. He/she will be able to quickly acquire new knowledge, carry out the necessary literature research and synthesize documents, acquire new working methods, organize him/herself and plan his/her work in order to implement the actions and solutions necessary to achieve the objectives of specifications that he/she will have helped to set. He/she will be able to seek innovative solutions, reason on applied problems while taking into account the constraints, work in a team, communicate on a scientific and technical level with all the actors of the project (students, teachers, industrial partners, external experts).

**Syllabus:**

Students must choose a project topic among the three types of projects:

ATI: Transfer and Innovation Workshop. These projects are based on a real professional and / or industrial issue raised by an industrial partner. They first carry out documentary research, then, depending on the subject, the work gives rise to experiments or calculations carried out at school or in a research laboratory.

GAIA: The GAIA workshops are a joint educational program with ENSA (National School of Architecture), EEIGM and ENSGSI (National School of Systems and Innovation Engineering) which aims to promote cooperation between the University and the Companies around concrete projects. These challenges are part of the ATI system but further expand the number of partners involved in the project.

PDE: These projects aim to promote EEIGM, Materials Engineering and Science among school audiences and students (schoolchildren up to post-baccalaureate), the general public, local businesses and Former Students.

Support training:

Prior to these projects, students follow a 1h15 course in bibliographic research, and in parallel training in writing a scientific report, writing a bibliography and oral presentation.

The "project" groups are also monitored by the manager of the "Project Management" course in order to help them to apply the concepts seen in the lecture and to support them in the overall organization of the project.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Organization: collaborative work within a group of varying size (3 to 6) depending on the project, at the rate of half a day per week; it is headed by one or more tutors during regular meetings. An appointment is scheduled with the project management teacher.

Assessment: final oral defense (20% of the final mark), final report (20% of the final mark), project management (60% of the final mark) - Educational resources: Project Management course

**Student’s expected work in autonomy:**

Autonomous work guided by the tutor during meetings whose frequency is defined by the tutors and students.

**Bibliographic references:**

De la gestion de projet au management par projet : maîtriser les risques d'une organisation transversale. (AFNOR, DL 2002), Muller, J.L. - Conduite et gestion de projets : principes et pratiques pour petits et grands projets, Chvidchenko I., Chevallier J., Cépaduès-éd, 1993

Toutes les ressources de l'université (articles scientifiques, Techniques de l'Ingénieur, bases de brevets etc.).

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream**:** Writing workshops, Orthodidacte, Project management, Financial management | Downstream**:** Research internship, Industrial internship |

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| **Teaching Unit:** PROFESSIONAL AND PERSONAL PROJECT | | **Year/Semester of AMASE studies:** 1st year – semester 8 | | | | |
| **Course manager:** **F. PAUL-CAVALLIER** | | | | |
| **EEIGM Department:** **Development and research** | | **Hours/student:** | | | | |
| **Teaching method**: Active Learning | | **In-person classes:** 5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Competencies approach | | 2.5 | 2.5 |  |  |  |
| **Autonomous work:** | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to:

• Identify the tracks of his/her professional project

• Prepare and choose his/her orientation

• Practice job interviews

**Syllabus:**

• MD1: Start a reflection on a project

Part 1: where to start

Part 2: how to organize

Part 3: what to do

TD 1: Use of tools

CV + SWOT and Professional Projection

Your research agents

Your Linkedin or Viadeo account

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Organization

2 lectures (MD1 and MD2) with exercises in the form of online quiz (googleForm)

4 groups for tutorials

Several groups of 4 people for tutorials (optional)

Possible meeting by reservation for individual adjustments after each session

Resources

PPT for theoretical contributions

Mobile or laptop with internet connection for exercises and tutorials

PDF supports to carry out some exercises or to prepare oneself for job interviews

Interviews can be filmed

Evaluation

Attendance at compulsory lectures and tutorials (List of students / list of those present)

Assessment

**Student’s expected work in autonomy:**

Prepare your CV and cover letter

Go into the materials produced online in depth

Identify one or more job advertisements

Search for company information

Prepare for job interviews

**Bibliographic references:**

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream**:** | Downstream**:** |

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| **Teaching Unit:** French as a Foreign Language VI | | **Year/Semester of AMASE studies:** 1st year – semester 8 | | | | |
| **Course manager:** **K. HENRY** | | | | |
| **EEIGM Department: European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 30 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 30 |  |  |  |
| **Autonomous work:** 6 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to take the DELF B2 or DALF C1 exams, exams for which he will have received intensive preparation.

He will be able to understand and use the language with greater ease and spontaneity, on familiar or unfamiliar subjects, concrete or more abstract, even complex. The skills of comprehension and expression, both oral and written, will be strengthened.

**Syllabus:**

Discovery of the methodology and training for the DELF B2 or DALF C1 tests. Deepening of skills (CO, CE, EO, EE) to meet the expectations of the exam.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Distribution of students in groups according to the level obtained at the end of the previous semester and the targeted examination.

Assessment based on attendance, class participation, personal work provided to pass the exam (rendering of written productions, simulations of the oral test)

The materials used in class are examples of tests.

DELF/DALF mock exam during the semester.

**Student’s expected work in autonomy:**

Complementary exercises: other tests; written production exercises; preparation of presentations.

**Bibliographic references:**

The www.ciep.fr site; books "Réussir le DELF B2" and "Réussir le DALF C1", Didier editions; "Preparation à l'examen du DELF B2", Hachette editions

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream**:** French as a foreign language V | Downstream**:** |

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| **Teaching Unit:** ENGLISH VI | | **Year/Semester of AMASE studies:** 1st year – semester 8 | | | | |
| **Course manager:** **N. BRIE** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method:** Academic | | **In-person classes:** 26.25 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 26.25 |  |  |  |
| **Autonomous work:** 10 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to obtain his/her mandatory FCE, CAE or CPE Cambridge examination.

**Syllabus:**

One group (B1/B2 level) follows a 26.25-hour course : consolidation of vocabulary and grammar, improvement of the students' level in the four skills: written expression, oral expression, written comprehension, oral comprehension. This group will follow an intensive FCE preparation course in 4th year.

The other groups (B2/C1/C2 levels) follow a 26.25-hour intensive course preparing for the June session of the FCE, CAE or CPE examinations.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

FCE/CAE/CPE past exams and practice tests for B2/C1/C2 levels

Authentic documents from the Anglo-Saxon media

Continuous assessment on FCE or CAE papers at B2/C1 levels

**Student’s expected work in autonomy:**

FCE/CAE/CPE past exams and practice tests for B2/C1/C2 levels

Authentic documents from the Anglo-Saxon media

Continuous assessment on FCE, CAE or CPE papers at B2/C1/C2 levels

**Bibliographic references:**

Grammar for FCE/CAE/CPE

Vocabulary for FCE/CAE/CPE

FCE/CAE/CPE practice tests

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream**:** V 26.25 | Downstream**:** |

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| **Teaching Unit:** SPANISH 6 BEGINNERS | | **Year/Semester of AMASE studies:** 1st year –semester 8 | | | | |
| **Course manager:** **C. SAVARD-CHAMBARD** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 37.5 |  |  |  |
| **Autonomous work:** 3 h per week | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should have acquired basic notions to understand and be understood in situations of everyday life. Levels to achieve A2 to B1 (self-assessment grid European Framework

**Syllabus:**

Acquisition of basic knowledge and skills necessary to understand and express oneself both orally and writing

**Pedagogical procedures (organization, assessment, pedagogical resources):**

ELE method and tuition in small groups (maximum 18 students)

Continuous assessment: evaluation of the 5 language skills

Studies of Spanish press articles and use of texts and audio recordings available on the Cervantes Institute web-site

**Student’s expected work in autonomy:**

Assimilation of knowledge and expertise

Prepare oral presentations on everyday life topics

Use of the resources of the library and language lab

**Bibliographic references:**

Class workbook: Campus Sur A1-A2 Libro del alumno y Cuaderno de ejercicios, Difusión, 2019

Grammar book: Competencia gramatical en uso, Nivel A2, Edelsa, Madrid, 2008

Bilingual dictionary Larousse

Vocabulary book: Maribel Molio, 60 fiches de vocabulaire espagnol, Studyrama, Paris, 2012

Conjugation book: Bescherelle, El arte de conjugar en español

**Other AMASE courses directly linked to this course:**

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| Upstream**:** Spanish V | Downstream**:** |

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| **Teaching Unit:** Spanish 6 LV2 or LV3 | | **Year/Semester of EEIGM studies:** 1st year –semester 8 | | | | |
| **Course manager:** **C. SAVARD-CHAMBARD** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 18,75 Niveaux B2 et +  26,25 Niveaux A2, B1et Prepa DELE (LV2-LV3) |  |  |  |
| **Autonomous work:** 3 h per week | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to depending on the groups, prepare for the Spanish DELE examination (B2, C1 or C2 levels) or reason by oneself on current topics, personal or professional interest

**Syllabus:**

For students preparing the DELE: training written and oral tests

For other students: consolidation and enrichment of knowledge and skills on current topics and professional issues

**Pedagogical procedures (organization, assessment, pedagogical resources):**

ELE method and tuition in small groups (maximum 18 students)

Continuous assessment: past DELE examinations B2 level + 2 DELE mock exams

Continuous assessment: evaluation of the 5 language skills

Past DELE examinations

Class workbooks: 1/ and 2/ Al dí@: curso intermedio de español para los negocios, Libro del alumno y Cua-derno de ejercicios, SGEL, Madrid, 2010

**Student’s expected work in autonomy:**

Assimilation of knowledge and expertise

Training past DELE examinations

Prepare oral presentations on social or current topics

Use of the resources of the library and language lab

**Bibliographic references:**

Workbooks: 1/ 1/ Las claves del nuevo C1, Difusión, 2016; 2/ C de C1. Curso de español de nivel superior, Difusión, 2019; 3/ Preparación al Diploma de Español, Nivel B2, Edelsa, 2018

Grammar books: 1/ Las 500 dudas más frecuentes del español, Espasa Calpe, 2019; 2/ Competencia gramati-cal en uso Nivel B2, Edelsa, Madrid, 2014

Dictionaries: 1/ Le vocabulaire de l'espagnol, Hachette, Paris, 2010; 2/ Diccionario de la lengua española, Real Academia Española, Madrid, 2012

Vocabulary book: 100 fiches de vocabulaire espagnol, Studyrama, Paris, 2010

Conjugation book: Bescherelle, El arte de conjugar en español

**Other AMASE courses directly linked to this course:**

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| Upstream**:** Spanish 5 | Downstream**:** |

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| **Teaching Unit:** German VI 16 | | **Year/Semester of AMASE studies:** 1st year semester 8 | | | | |
| **Course manager:** **H. Khöler-Betous** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 16.25 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **4Assessment:** Classic | |  | 16.25 |  |  |  |
| **Autonomous work:** 4 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to practice German with the level B1+ or B2 ("Independent User"), or C1 or C2 (Proficient User") of the Common European Framework of Reference for Languages (CEFR).

**Syllabus:**

Consolidation and enrichment of the language.

Training reception ("listening" and reading"), production ("speaking" and "writing") as well as interaction ("taking part in a discussion").

In-depth knowledge of the realities of the German speaking countries.

Possibly and depending on the level of the group, introduction to scientific, technical and/or commercial German.

Help in finding the stay in a German speaking country.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Working in groups according to the level.

Continuous assessment.

Use of course books, original documents and on-line resources.

**Student’s expected work in autonomy:**

Diverse application exercises, including reception and production.

**Bibliographic references:**

https://www.goethe.de/de/spr/kup/prf/prf.html

https://www.dw.com/de/deutsch-lernen/lernangebote-f%C3%BCr-das-niveau-b2/s-13217

"Begegnungen B1+", Schubert

"Erkundungen B2", Schubert

"Studio B2/C1", Cornelsen

"Ziel B2/C1", Hueber

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream**:** German V 19 | Downstream**:** German VII |

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| --- | --- | --- | --- | --- | --- | --- |
| **Teaching Unit:** German VI 28 | | **Year/Semester of EEIGM studies:** 1st year- semester 8 | | | | |
| **Course manager:** **H. Köhler-Betous** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 28 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 28 |  |  |  |
| **Autonomous work:** 5 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should

be able to practice German with the level A2 ("Basic User") of the Common European Framework of Reference for Languages (CEFR).

**Syllabus:**

Consolidation and enrichment of the language.

Training reception ("listening" and reading"), production ("speaking" and "writing") as well as interaction ("taking part in a discussion").

Introduction to the realities of the German speaking world.

Help in finding the stay in a German speaking country.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Continuous assessment.

Use of course books, original documents and on-line resources.

**Student’s expected work in autonomy:**

Diverse application exercises, including reception and production.

**Bibliographic references:**

"Menschen A2", Hueber

"Studio A2", Cornelsen

**Other AMASE courses directly linked to this course:**

|  |  |
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| Upstream**:** German V 26 | Downstream**:** |

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| **Teaching Unit:** German VI 38 | | **Year/Semester of EEIGM studies:** 1st year – semester 8 | | | | |
| **Course manager:** **H. Köhler-Betous** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 37.5 |  |  |  |
| **Autonomous work:** 10 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to practice German with the level A1 ("Basic User") of the Common European Framework of Reference for Languages (CEFR).

**Syllabus:**

Introduction to the German language.

Training reception ("listening" and reading"), production ("speaking" and "writing") as well as interaction ("taking part in a discussion").

Introduction to the realities of the German speaking world.

Help in finding the stay in a German speaking country.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Continuous assessment.

Use of course books, original documents and on-line resources.

**Student’s expected work in autonomy:**

Diverse application exercises, including reception and production.

**Bibliographic references:**

"Menschen A1", Hueber

"Studio [21] A1", Cornelsen

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** German V 38 | Downstream**:** |

**Nom complet de l’UE : UE803a Solidification**

Composante de rattachement : Faculté des Sciences et Technologies

Nom du responsable de l’UE et adresse électronique : [benoit.appolaire@univ-lorraine.fr](mailto:benoit.appolaire@univ-lorraine.fr)

Semestre : 8

Langue d’enseignement de l’UE : Français

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Enseignements composant l’UE | CNU | CM | TD | TP | EqTD |
| Solidification | **33** | 9 | 9 | 12 | 34,5 |

# Descriptif

Solidification

- Produits et procédés (transferts thermiques en solidification)

- Structure des grains : contrôle, inoculation, germination, croissance des cristaux équiaxes

- Microstructures et microségrégations : ségrégation devant un front plan, instabilité du front,

croissance colonnaire dendritique, solidification eutectique, microségrégations, inclusions, microporosités.

# Pré-requis

Bases en mécanique du solide et en structure des matériaux

# Acquis d'apprentissage

L'étudiant sera capable de décrire les scénarios menant aux microstructures des alliages

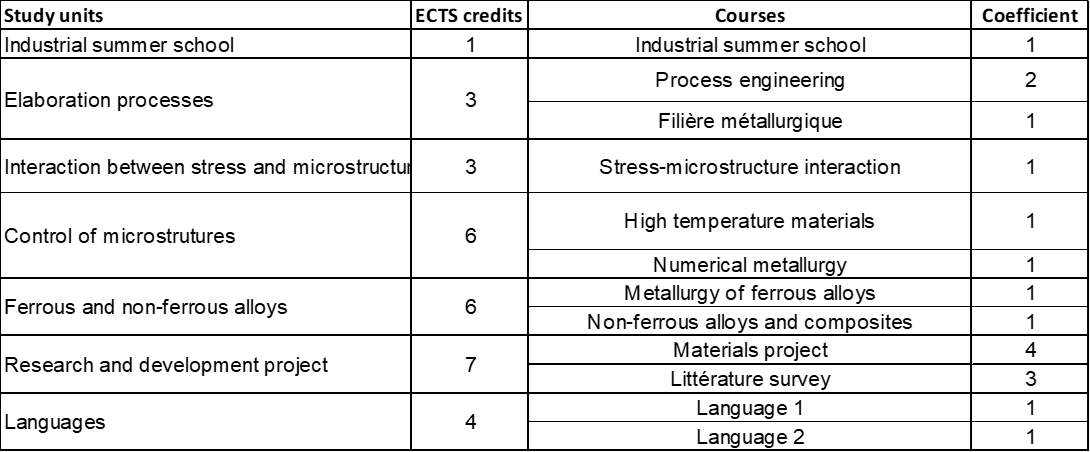
métalliques lors de la solidification. Il saura diagnostiquer les défauts et leur origine à l’issue de la solidification.

# Compétences visées

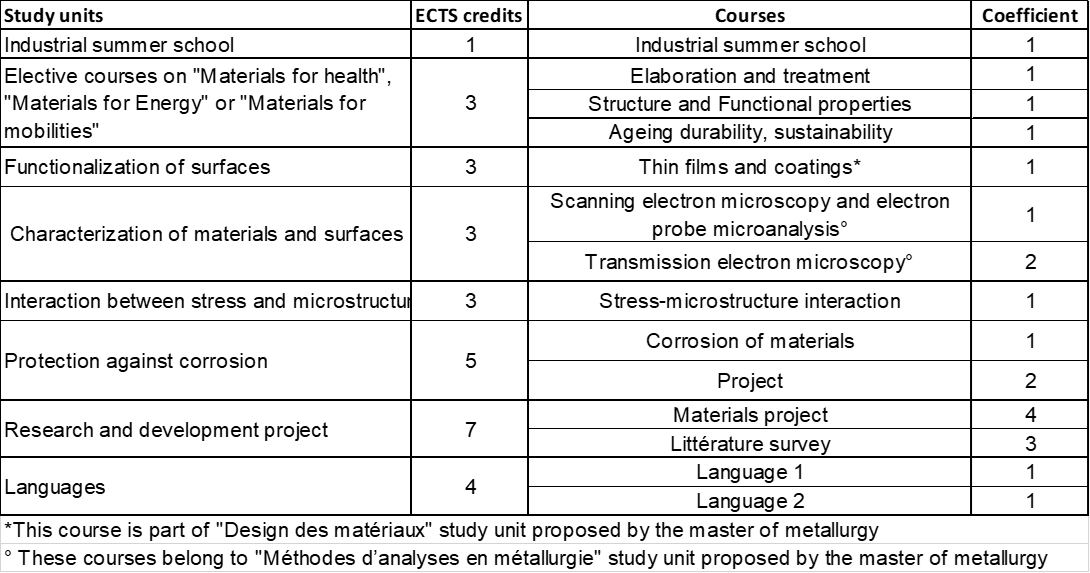
* Comprendre comment se forment les microstructures en vue de proposer/optimiser des traitements (thermiques, thermomécaniques, de surface) pour améliorer les propriétés des matériaux métalliques ; savoir utiliser les outils permettant la prévision des évolutions microstructurales des matériaux métalliques.
* Comprendre un procédé métallurgique afin de prévenir l’occurrence de défauts et optimiser les propriétés, voire d'optimiser la production, voire de concevoir de nouveaux procédés.
* Identifier les relations compositions-microstructures-propriétés, en vue de les mettre en œuvre pour développer ou améliorer un matériau métallique, en intégrant les aspects contrainte et déformation
* Développer une conscience critique des savoirs dans un domaine et/ou à l’interface de plusieurs domaines
* Résoudre des problèmes pour développer de nouveaux savoirs et de nouvelles procédures et intégrer les savoirs de différents domaines

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|  | 2nd year |
|  | [SEMESTER 9] | |

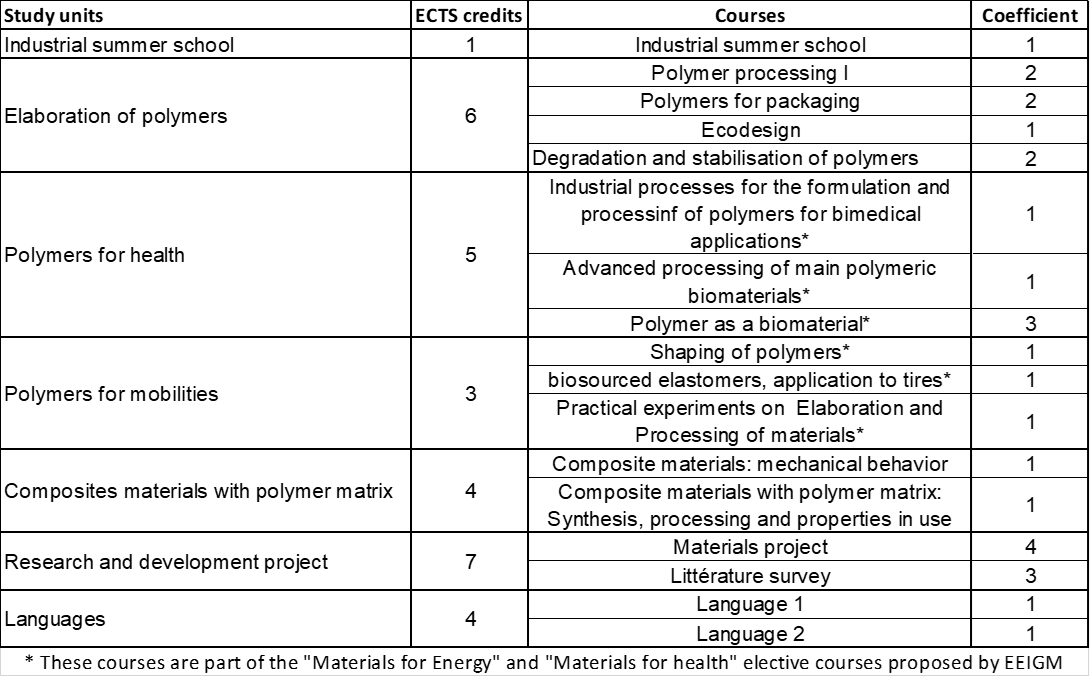
**Track 1**

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**Track 2**

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**Track 3**



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| --- | --- | --- | --- | --- | --- | --- |
| **Teaching Unit:** Composite materials: mechanical behavior | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **L. TERREI** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 22.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 12.5 | 8.75 | 5 |  | 1.25 |
| **Autonomous work:** | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to determine analytically (Love-Kirchhoff’s theory) and numerically (Abaqus®) the mechanical state (field of displacements, strains and stresses) of a not symmetric and unbalanced composite thin plate subjected to combined biaxial traction/compression, pure cutting, temperature loading (uniform), flexion, buckling and free vibrations (in these last three cases, only in the case of a crossed plate where 4 edges are in free supports) and who(which). The orthotropic materials’ behavior will be supposed linear elastic. The student will beforehand have been made aware to the various families of existing composites on the market (materials for the reinforcements and the matrices, arrangement of the reinforcements, charges) as well as in their mechanical properties.

**Syllabus:**

Majorities on composite materials, Love-Kircchoff’s theory, traction, flexion, free vibration, buckling, thermo-elasticity

**Pedagogical procedures (organization, assessment, pedagogical resources):**

The student has a duplicated lecture note said "with hole " (documents which resumes all the slides of the lecture but in a incomplete way so that the student remains active by filling and by annotating the latter), of a collection of exercises of TD.

The student is evaluated by an homework (coef 1) and a final control of 2 hours (coef 1).

**Student’s expected work in autonomy:**

Every week, the student will have to work again the points of the course which were not assimilated in session and to prepare the questions of the next TD indicated by the teacher

**Bibliographic references:**

• Agarwal B. and al, Analysis and Performance of Fiber composites, Wiley, 2006

• Berthelot J.M., Matériaux composites, Masson

• Chawla K.K., Composite Materials, Springer Verlag, 1998

• Jones R., Mechanics of Composite Materials, Taylor & Francis, 1999

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** Elaboration des Matériaux Composites à Matrice Polymère, |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Teaching Unit:** Composite materials with polymer matrix: Synthesis, Processing and Properties in use | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **I. ROYAUD** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 13.75 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 10 | 2.5 |  |  | 1.25 |
| **Autonomous work:** 13.75 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to synthetize, design and develop composite materials with a polymer matrix by choosing the appropriate matrix, the type of reinforcement and the production process to be implemented in order to obtain specific and controlled properties. The association in a composite material of a continuous polymer matrix and reinforcements produces a synergistic effect between the properties of the different constituent elements which the student will take advantage of to contribute to the development of composites while respecting specifications typical of many applications in most common industries.

**Syllabus:**

I- Polymer chemistry for polymer matrix composites (A. Jonquières) :

Chemistry of the main thermoplastic (widely distributed, technical and high-performance) and thermosetting polymer matrices (unsaturated polyesters, polyepoxides, phenol-formaldehyde technical matrices; high-performance polyimide matrices; notions of gel effect and critical conversion rate) .

II- Processing and properties of polymer matrix composites (I. Royaud) :

Methods of elaboration of reinforcing fibers, Methods of elaboration of semi-products, pre-pregs and composites with thermoplastic and thermosetting matrices, focus on mechanical and physical properties vs processed final products.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Educational resources: 1 handout "Polymer chemistry for polymer matrix composites" (A. Jonquières) and 1 handout (I. Royaud) Processing and properties of polymer matrix composites.

A final test of 1h15 on the synthesis (37 min with A. Jonquières) and on the processing and the resulting physical properties (37 min with I. Royaud) of composites with a polymer matrix.

**Student’s expected work in autonomy:**

Re-read and integrate the lectures, prepare the tutorials, obtain information on the subjects covered related to composites (matrix chemistry, use of composites, physical properties of composites) through personal research.

**Bibliographic references:**

• Chrétien G., Matériaux composites à matrice organique, 1986, Tec et Doc, Paris

• Cognard P., Les applications industrielles des matériaux composites, 2 volumes, Edition du Moniteur (1989)

• Gay D., Matériaux composites, 1991, Chapitre 5, Hermes, Paris

• Renard J. ed, Elaboration, microstructure et comportement des composites à matrice polymère, 2005, Hermès-Science, Paris

• Reyne, Technologie des composites, 1990, Hermès, Paris

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** Macromolecular chemistry, Relations between Structures / Physical Properties of Polymers, Degradation and Stabilization of Polymers, Composite materials: mechanical behavior | Downstream**:** Polymerization Engineering, Biopolymers and Biodegradable Polymers |

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| **Teaching Unit:** Elective course Materials For Mobility-Theme 3: Electromobility/Performance | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **T. CZERWIEC** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 10 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Competencies approach | | 10 |  |  |  |  |
| **Autonomous work:** 3 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to better understand the sustainable development objectives contained in the new forms of mobility. The evolution of the hydrogen sector in electromobility will be regularly reviewed. The student will also be introduced to the contribution of surface treatments in improving the performance of mobility devices. Finally, the student will be introduced to mechatronics and intelligent mobility.

**Syllabus:**

The electromobility/performance axis (15 lectures) is part of the materials for mobility option and a certain number of the modules (7 lectures) that make it up are taught in 3A. It consists of 3 modules (8 lectures):

Module 3.1 – Hydrogen and electromobility sector. Fuel cell (2.5 h) and electric vehicle (2.5 h): 2 lectures

Module 3.2 – Energy performance. Surface treatment to improve performance (1.25 h): 1 lecture

Module 3.3 – Mechatronics, smart mobility. Surface treatments for functional applications (1.25 h), artificial intelligence (2.5 h): 3 lectures

**Pedagogical procedures (organization, assessment, pedagogical resources):**

The course includes 8 lectures sessions. Copies of the slideshows presented, available on ARCHE. The evaluation is carried out by groups of students in various forms: writing of a summary note giving an update on a technique or a problem of the hydrogen sector or surface treatments.

**Student’s expected work in autonomy:**

Drafting of the summary note mentioned above.

**Bibliographic references:**

ttps://www.economie.gouv.fr/presentation-strategie-nationale-developpement-hydrogene-decarbone-France

http://www.cea.fr › energies › essentiel-sur-hydrogene

**Other AMASE courses directly linked to this course:**

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| Upstream**:** Physical properties of materials | Downstream**:** Industrial and/or research projects |

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| **Teaching Unit:** Materials for health. Theme 2 | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **J-L. SIX** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials/Ageing, durability, sustainability** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 20 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 18.75 |  |  |  | 1.25 |
| **Autonomous work:** 20 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to master the polymerization and plasturgy processes used to produce polymeric biomaterials. Some additive manufacturing techniques used to elaborate ceramic or polymeric biomaterials or to build biotissues will be discussed.

**Syllabus:**

Presentation of the principles of industrial processes for the synthesis and formulation of polymers used in biomedical applications; of their scientific/technical challenges and of some industrial examples.

Presentation of the main used polymeric biomaterials forming processes, of their scientific/technical challenges and os some industrial examples.

Presentation of the main methods of additive manufacturing of biomaterials and biotissues, as well as recent advances in the field.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Resources: 1 course handout.

Evaluation: 1h15 test.

**Student’s expected work in autonomy:**

At regular intervals, student has to review and learn lectures.

**Bibliographic references:**

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** Materials for health. Theme 3 |

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| **Teaching Unit:** Polymer Processing | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **G-H. HU** | | | | |
| **EEIGM Department:** **Elaboration and processing of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Active Learning | | **In-person classes:** 13.75 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 6.25 | 6.25 |  |  | 1.25 |
| **Autonomous work:** 12.5 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to master basic notions of polymer processing and the working principles of the main polymer processing technologies.

**Syllabus:**

1. What are the concrete applications for polymer materials? 2. What are the main processes for processing polymer materials? 3. How does the extrusion process work? 4. How does the injection molding process work? 5. What manufacturing defects can the extrusion and injection molding processes may face? What are their physical origins of these defects? How to solve them? 6. How do polymer processing technologies take into account the molecular, thermal and rheological characteristics of polymer materials?

**Pedagogical procedures (organization, assessment, pedagogical resources):**

1. The course includes 5 lessons of 75 min each and the same amount of tutorials. No practical work, however. 2. The handouts are provided as a support, 3. The evaluation is done via a standard examination without document whose subjects are based on the method: "SEE-I" which designates "State it, Elaborate, Exemplify, and Illustrate ”.

**Student’s expected work in autonomy:**

1. It is very strongly recommended to actively attend all the lessons and tutorials. 2. It is important to apply the “SEE-I” method during the active learning of this course.

**Bibliographic references:**

1. Agassant J.F., La mise en forme des matières plastiques, 2. Bost J., Matières plastiques (Tomes 1 et 2) , 3. Michaeli W., Extrusion des matières plastiques, 4. Rauwendaal C., Polymer extrusion, 1986, Hanser publishers

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** research projects |

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| **Teaching Unit:** elective course Materials For Mobility-Theme 1: Conception/Elaboration | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **G-H. HU** | | | | |
| **EEIGM Department:** **Elaboration and processing of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 37.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 37.5 |  |  |  |  |
| **Autonomous work:** 9 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should able to understand the rheological behavior of polymers in the molten state, model the flow of molten polymers in simple geometries, understand the mixing mechanisms in viscous systems and apply them to the development of polymer matrix composites. He will also be able to make the link between his theoretical knowledge and the technological tools used for the development of metallic materials and the necessary compromises and consequences on the finished products.

**Syllabus:**

The design/development axis consists of two mobility-oriented modules (29 lectures).

Module 1.1 – Design and Elaboration course (shaping polymers (10h), polymers for lightening (5h) and Elaboration of more environmentally friendly steels made by manufacturers from Arcelor Mittal and Lisi Automotive (12.5h) The "polymer processing" course (8 lectures) presents the rheology of polymers in the molten state, the flow of molten polymers in simple geometries, industrial processes for shaping polymer materials, the mechanisms and mixing tools for highly viscous systems. The "Polymers for lightening" course (4 lectures) presents the challenges, principles and industrial strategies around the use of polymer materials to lighten transport equipment.

Module 1.2 – Transport industries including presentations by industrials (Airbus, Safran, ESA, Coventia, Arcelor Mittal (8.25 h: 7 lectures) as well as courses on high and ultra-high temperature ceramics and ceramics with composite matrix (2.5 h: 2 lectures)

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Module 1.1: For “Processing polymers”: Handouts are provided as support. The assessment is carried out via a classic examination without documents. For: "Polymers for lightweighting": Handouts are provided as support. The evaluation is carried out in the form of mini-projects linked to the design of polymer parts for the reduction of transport equipment.

Module 1.2: The production lines and the choice of tools according to the final part application are described by an industrial who has worked in the steelworks then in customer relations for the cold heading and hot forging trades before to integrate R&D. Assembly methods are covered by an industrial specialist in solutions for the automotive market. The assessment is carried out in the form of a MCQ.

**Student’s expected work in autonomy:**

Research on examples of industrial applications related to mobility.

**Bibliographic references:**

1. Agassant J.F., Processing plastics, 2. Bost J., Plastics (Tomes 1 et 2) , 3. Michaeli W., Extrusion of plastics , 4. Christopher W. Macosko, Rheology: Principles, Measurements, and Applications, 1994. ISBN: 978-0-471-18575-8, 5. Ica Manas-Zloczower, Mixing and Compounding of Polymers: Theory and Practice. 2nd Edition. 2009

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** research projects |

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| **Teaching Unit:** Elective course Materials for health. Theme 3 | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **J-L. SIX** | | | | |
| **EEIGM Department:** **Elaboration and processing of materials** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 40 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 38.75 |  |  |  | 1.25 |
| **Autonomous work:** 40 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to understand why polymeric, metallic, ceramic or carbon materials have been used in the biomedical field, taking into account the specifications imposed by the targeted applications.

**Syllabus:**

After having defined a biomaterial, the general concepts of biocompatibility and biodegradation will be presented. The fields of use of the different classes of biomaterials will be discussed, as well as economic data. The post-implantation fate of biomaterials will be introduced by focusing on the consequences of the different chemical and physical degradations of the material on the evolution of its properties.

Many biomaterials will be illustrated (total hip prosthesis, external prosthesis made of carbon material, non-biodegradable or bioresorbable ceramic prostheses, ocular implants, systems for drug delivery, catheters, materials for dentistry, materials for tissue engineering, …).

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Resources: 1 course handout.

Evaluation: 1h15 test + a personal synthesis work

**Student’s expected work in autonomy:**

At regular intervals, student has to review and learn lectures.

**Bibliographic references:**

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** |

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| **Teaching Unit:** Degradation and Stabilisation of Polymers | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **A. JONQUIERES** | | | | |
| **EEIGM Department: Ageing, durability, sustainability** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 10 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Competencies approach | | 7.5 | 1.25 |  |  | 1.25 |
| **Autonomous work:** 10 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to

• Identify the causes of a polymer chemical degradation on the basis of first-hand informations

• Define a strategy for its prevention and reasonably implement an appropriate combination of stabilising agents

• Stabilise a polymer efficiently for its processing or its intended uses

• Appraise a physical degradation on the basis of different characterisations and specify its consequences on the material physical properties

**Syllabus:**

• The consequences of chemical and physical degradation on polymer properties

• The different types of chemical and physical degradations

• The different mechanisms involved in polymer material degradation

• The industrial strategies for polymer stabilisation with the reasoned use of various stabilising agents (i.e. thermal, photochemical, fungicide, bactericide, and fireproof stabilising agents)

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Pedagogical ressources : 1 handout "Chemical degradation and stablisation of polymers" (6.25h lectures including case studies/A. Jonquieres) and 1 handout "Physical degradation of polymers: physical aging" (1.25h lectures/1.25h TD/I. Royaud).

A final test on chemical degradation and stabilisation of polymers on the basis of case studies (50 min with A. Jonquières) and on physical degradation of polymers (25 min with I. Royaud)

**Student’s expected work in autonomy:**

The student will have to practice the different concepts seen in lectures and tutorials on different case studies

**Bibliographic references:**

• J. Verdu, Vieillissement chimique des plastiques : aspects généraux, Les Techniques de l’Ingénieur, Traité Plastiques et Composites, Volume AM 3 151, 2002.

• J. Ecole J., La stabilisation des polymères, Nathan, Encyclopédie technique pratique, 1991, 75 pages.

• J. Verdu et B. Fayolle,Vieillissement Physique des matériaux polymères, Les Techniques de l’Ingénieur, A3150, Cor108, 2005.

• M. Biron, Vieillissement et durabilité des polymères à usage industriel : plastiques, élastomères et leurs composites, Tech Tendances, Etudes Technologiques, Innovation 128, Paris, Boston, Tokyo, 2001. ISBN : 2-906024-42-2.

• W.L. Hawkins, Polymer Degradation and Stabilization, Springer, 1984.

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** Composite materials with polymer matrix: Synthesis, processing and properties in use. Polymer reaction engineering. Biopolymers and biodegradable polymers. Biomedical applications of polymers. Functional polymers. |

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| **Teaching Unit:** Elective course Materials For Mobility-Theme 2: Durability/Safety | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **I. ROYAUD** | | | | |
| **EEIGM Department: Ageing, durability, sustainability** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 23.75 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 23.75 |  |  |  |  |
| **Autonomous work:** 8 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to understand the challenges of biosourced materials and surface treatments in terms of durability and safety of materials in the field of mobility.

**Syllabus:**

This axis is divided into two modules (19 lectures).

Module 2.1 – Biosourced materials for mobility itself consists of two courses:

-The course on biodegradable, biosourced, biopolymers (Anne Jonquières, 10h, 8 lectures) is treated in 3A (see specific syllabus sheet for the 3A program)

- The course on biosourced rubbers, application to tires (green tires and recovery of used tires), (Guo-Hua Hu, 5 h). This course presents the scientific and technical challenges of material recovery from used rubbers (particularly tires), the chemistry of biosourced rubbers as well as new chemistries and processes for vulcanization and devulcanization of rubbers.

Module 2.2 – Surface Treatments and Corrosion

In this module we will present thermal barrier coatings and matrix nanocomposite coatings.

ceramics (1.25 h, David Horwat). Certain aspects of surface and corrosion treatments to improve safety and durability in mobility (5 h, Thierry Belmonte and Thierry Czerwiec, 2.5 h, Delphine Renaux)

**Pedagogical procedures (organization, assessment, pedagogical resources):**

For module 2.1: The course on green tires includes 4 lectures; handouts are provided; the assessment is carried out in the form of mini-projects linked to the design of rubbers that are more easily recyclable or biodegradable.

For module 2.2: students will have copies of the slideshows presented, available on ARCHE. The evaluation is carried out by groups of students in various forms: study of specific cases of surface treatments, analysis of articles.

Evaluation to be harmonized with the 3 other axes of the Option, a single mark for the 3 axes will be given for the Materials for Mobility option. In 4A: this mark will be the average of 2 classic tests and 1 project.

**Student’s expected work in autonomy:**

For Module 2.1: Research on examples of industrial applications of rubbers related to mobility.

For module 2.2 Very little extra-curricular work is required of the students. A different approach, allowing them to pragmatically exploit their knowledge, is implemented to assess the new skills acquired in this module.

**Bibliographic references:**

See the references given in the course materials.

**Other AMASE courses directly linked to this course:**

|  |  |
| --- | --- |
| Upstream**:** Lectures in metallic materials, physics, chemistry, polymers and composites | Downstream**:** research projects |

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| **Teaching Unit:** Theme 2-Elective course Materials for Energy | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **D. HORWAT** | | | | |
| **EEIGM Department:** **Structural and functional properties of materials/Elaboration and processing/Ageing, durability, sustainability** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 41.25 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 41.25 |  |  |  |  |
| **Autonomous work:** 20 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to understand challenges, concepts, and devices for energy production/conversion, transport, regulation and storage.

**Syllabus:**

A- Production / Conversion

 Fossil fuels (3 lectures)

• Heater, heat exchangers, materials

 Nuclear (5 lectures)

• Principles

• Materials for nuclear energy conversion: Manufacturing strategies and consequences on components properties, Ageing under irradition, thermal, corrosive environments

 Wind energy (3 lectures)

Principles and materials

 Fuel cells and hydrogen (6 lectures)

• Principles and electrochemical and electrocatalysis basics (L. Speyer 1 lecture)

• Materials and processes: Low temperature fuel cells (L. Speyer 1 lecture), Intermediate and high temperature fule cells (D. Horwat – 2 lectures)

• Hydrogen: Transport, storage, conversion (2 lectures)

 Micro harvesting (D. Horwat – 2 lectures)

B- Energy transport and regulation (7 lectures)

 Transport – insulation - regulation

• Principles and materials for thermal insulation (Z. Acem 2 lectures)

• Thermal regulation - smart windows: low emissivity, thermochromism, photochromism, electrochomism (D. Horwat – 2 lectures)

C- Storage (7 lectures)

 Capacitors - supercapacitors

• Principle: Dielectrics for electrical energy storage (S. Hilpert - 1 lecture)

• Materilas and processes: inorganic (S. Hilpert - 1 lecture), organic (I. Royaud - 1 lecture)

 Batteries

• Electrochemical principles (L. Speyer 1 lecture)

• Materials et processes: inorganic (L. Speyer 1 lecture), organic (I. Royaud - 1 lecture)a

 Heat accumulators

• Materials: bulk accumulators, phase change materials (D. Horwat 1 lecture)

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Classic teaching, written exam and submission of a report

**Student’s expected work in autonomy:**

personnal work to understand concepts, processes and origin of properties

**Bibliographic references:**

Scientific articles

**Other AMASE courses directly linked to this course:**

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| --- | --- |
| Upstream | Downstream**:** Project materials for energy |

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| **Teaching Unit:** Theme 3 - Ageing and recovery of materials for energy (Elective course: Materials for energy) | | **Year/Semester of EEIGM studies:** 4A - 1st semester | | | | |
| **Course manager:** **M-O. SIMONNOT** | | | | |
| **EEIGM Department:** **Ageing, durability, sustainability** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 15 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | | 15 |  |  |  |  |
| **Autonomous work:** 15 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should better understand the fate and end-of-life of installations and materials used in the energy sector.

**Syllabus:**

A- The nuclear sector: dismantling of installations and waste management (7 lectures)

B- Recycling of non-nuclear materials (batteries, fuel cells, renewable energy, etc.) (4 lectures)

C- Life cycle analysis and carbon footprint of these sectors (4 lectures)

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Classical exam

**Student’s expected work in autonomy:**

In-depth study of the elements presented in class, analysis of documents such as articles, videos or radio broadcasts

**Bibliographic references:**

**Other AMASE courses directly linked to this course:**

|  |  |
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| Upstream**:** | Downstream**:** All disciplines of the Materials for Energy option |

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| **Teaching Unit:** Materials Project | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **J. ZOLLINGER** | | | | |
| **EEIGM Department:** **Development and research** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 29.25 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Competencies approach | | 1.25 |  |  | 28 |  |
| **Autonomous work:** 4 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to identify key experiences, elaborate an experimental design, realize and analyze experiments to answer a scientific problem (either in the research or in the expertise field) in materials science.

**Syllabus:**

The students have 8 sessions to solve a scientific problem in materials science using all the equipment (experimental and numerical) at their disposal. The students present their work during the last session.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

A characteristic of this teaching unit is that there is no obligation of results! The proposed subjecst might be research related with no ensurance that the work will bring outcomes. However, the scientific approach, the voluntarism, curiosity and application of the knowledge gained during the previous semester allow the students to achieve great scientific studies in the field of metallurgy. The teaching unit is made of one session to organize the projects, of seven lab sessions and of one session for presenting their results. Assessment is performed based on the behaviour during the lab work, the quality of the report and of the oral presentation.

**Student’s expected work in autonomy:**

4h of work are required for writing a report and prepare an oral presentation. Extra hours during the project would definitively bring an added-value to the realized work.

**Bibliographic references:**

Project dependent

**Other AMASE courses directly linked to this course:**

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| Upstream**:** All the materials teaching units | Downstream**:** trainings |

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| **Teaching Unit:** English VII | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **N.BRIE** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 18 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 18 |  |  |  |
| **Autonomous work:** 5 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to obtain his/her mandatory FCE Cambridge examination

**Syllabus:**

This group concerns French and foreign students who entered the EEIGM in 3rd year with a weak level in English : they follow an 18-hour intensive FCE preparation course (9 sessions of two hours) in view of taking the FCE in December. The course is based on FCE practice tests and FCE past papers.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

FCE/CAE past exams and practice tests for B1/B2 level

"continuous assessment" (oral presentations and reports) or FCE papers at B2 level

**Student’s expected work in autonomy:**

Use of the resources of the Foreign Language Learning Center

**Bibliographic references:**

Grammar for FCE

Vocabulary for FCE

FCE practice tests

**Other AMASE courses directly linked to this course:**

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| Upstream**:** | Downstream**:** |

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| --- | --- | --- | --- | --- | --- | --- |
| **Teaching Unit:** Spanish VII | | **Year/Semester of AMASE studies:** 2nd year – semester 9 | | | | |
| **Course manager:** **C. SAVARD-CHAMBARD** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 17.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 17.5 |  |  |  |
| **Autonomous work:** 2h-3h per week | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to, depending on the groups, prepare the semester study in Valencia or Barcelona, the Spanish DELE examination (B2 and C1 levels) or acquire new knowledge on personal, professional or scientific topics.

**Syllabus:**

For students going to Barcelona or Valencia: consolidation of knowledge on everyday life, professional and scientific Spanish

For students preparing the DELE: training written and oral tests (DELE intermediate or advanced level)

For other students: conversation classes, presentations of cultural topics, dialogues on everyday life situations, writing CV and cover letters

**Pedagogical procedures (organization, assessment, pedagogical resources):**

ELE method and tuition in small groups (maximum 18 students)

Studies of advertisements, tourists guides and extracts of scientific books

Review of general and daily press

Continuous assessment: past DELE examinations B2 and C1 levels

Continuous assessment: evaluation of the 5 language skills

Past DELE examinations

**Student’s expected work in autonomy:**

Assimilation of knowledge and expertise

Training past DELE examinations

Prepare oral presentations on current topics and lectures on scientific subjects

Use of the resources of the library and language lab

**Bibliographic references:**

Workbooks: 1/ Campus Sur B1, Libro del alumno y Cuaderno de ejercicios, Difusión, 2019; 2/ Preparación al Diploma de Español Nivel C1, Edelsa, 2017; 3/ Preparación al Diploma de Español Nivel B2, Edelsa, 2018. Grammar books: 1/ Universo gramatical para estudiantes franceses, Edinumen, Madrid, 2016; 2/ Las 500 dudas más frecuentes del español, Espasa Calpe, 2019. Dictionaries: 1/ Le vocabulaire de l'espagnol, Hachette, Paris, 2014; 2/ Diccionario de la lengua española, Real Academia Española, Madrid, 2019. Vocabulary book: Maribel Molio, 60 fiches de vocabulaire espagnol, Studyrama, Paris, 2017. Conjugation book: Bescherelle, El arte de conjugar en español

**Other AMASE courses directly linked to this course:**

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| Upstream**:** Spanish 5 and 6 beginners, LV2 or LV3 | Downstream**:** |

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| **Teaching Unit:** German VII | | **Year/Semester of EEIGM studies:** 4A - 1st semester | | | | |
| **Course manager:** **H. Köhler-Betous** | | | | |
| **EEIGM Department:** **European languages and cultures, SEHS** | | **Hours/student:** | | | | |
| **Teaching method**: Academic | | **In-person classes:** 17.5 | | | | |
| Lecture | Tutorial | Lab work | Project | Test |
| **Assessment:** Classic | |  | 17.5 |  |  |  |
| **Autonomous work:** 5 | | | | |
| **Generic EEIGM competencies Specific EEIGM competencies** | | | | | | |
| **C1  C2**  **C3  C4  C5**  **C6  C7  C8** | **SC1  SC2**  S**C3  SC4  SC5**  **SC6** | | | | | |

**Educational objectives of the course:**

At the end of the course, the student should be able to practice German with the objective of reaching one of the following levels of the Common European Framework of Reference for Languages (CEFR):

- level B2 ("Independent User"), C1 or C2 ("Proficient User") for Upstream Unit German VI 16,

- level B1 ("Independent User") for Upstream Unit German VI 28,

- level A2 ("Basic User") for Upstream Unit German VI 38.

**Syllabus:**

Consolidation and enrichment of the language.

Training reception ("listening" and reading"), production ("speaking" and "writing") as well as interaction ("taking part in a discussion").

In-depth knowledge of the realities of the German speaking countries.

Possibly and depending on the level of the group, introduction to scientific, technical and/or commercial German.

**Pedagogical procedures (organization, assessment, pedagogical resources):**

Working in groups according to the level.

Continuous assessment.

Use of course books, original documents and on-line resources.

**Student’s expected work in autonomy:**

Diverse application exercises, including reception and production.

**Bibliographic references:**

https://www.goethe.de/de/spr/kup/prf/prf.html

https://www.dw.com/de/deutsch-lernen/lernangebote-f%C3%BCr-das-niveau-b2/s-13217

"Begegnungen B1+", Schubert

"Erkundungen B2", Schubert

"Menschen A2/B1", Hueber

"Studio A2/B1/B2/C1", Cornelsen

"Ziel B2/C1", Hueber

**Other AMASE courses directly linked to this course:**

**Nom complet de l’UE : UE902 Alliages ferreux et Non ferreux**

Composante de rattachement : Faculté des Sciences et Technologies

Nom du responsable de l’UE et adresse électronique :  [benoit.appolaire@univ-lorraine.fr](mailto:%20benoit.appolaire@univ-lorraine.fr)

Semestre : 9

Volume horaire enseigné : 75 heures, Nombre de crédits ECTS : 6

Volume horaire travail personnel de l’étudiant : 90 heures

Langue d’enseignement de l’UE : Français

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| Enseignements composant l’UE | CNU | CM | TD | TP | EqTD |
| Alliages Ferreux | **33** | 20 | 10 |  | 40 |
| Alliages Non Ferreux | **33** | 30 |  |  | 45 |

# Descriptif

Alliages Ferreux : Les aciers - Transformations de phases en cycles thermiques rapides : - mécanismes de l'austénitisation et de la mise en solution, croissance de grain - transformations au refroidissement en conditions isothermes (diagrammes TTT) et anisothermes (diagrammes

TRC) - rôle des éléments d'alliage - notion de trempabilité . Mécanismes de transformation

de phases au cours du revenu de la martensite - relations microstructures propriétés mécaniques.

Etudes de cas (Arcelor…)

Fontes : formation des microstructures de la solidification aux transformations de phases à l'état solide - traitements thermiques - relations microstructures propriétés mécaniques - Etude de cas (Critt Metall 2T…)

Non Ferreux Acquérir les notions de base concernant les grandes familles d'alliage de titane,

d’alliages d'aluminium, d’alliages base nickel , de composites à matrice métallique, les types

de traitements thermiques et thermomécaniques sur pièces. Prédire les évolutions

structurales du matériau selon le traitement thermique ou thermomécanique envisagé. Faire

le lien avec les caractéristiques finales du matériau.

Mises en application du cours par 5 TP dédiés à ces deux éléments constitutifs

# Pré-requis

Connaissances en transformations de phases et propriétés mécaniques des matériaux.

Notions de base en diagrammes de phases, diffusion, structure cristalline et défauts.

# Acquis d'apprentissage

Comprendre la formation des microstructures lors des traitements thermiques d'alliages ferreux et les conséquences sur les propriétés mécaniques - Etre capable de proposer un traitement thermique pour une pièce soumise à des sollicitations en service. Formation des microstructures et relations microstructures/propriétés, des alliages de titane, des alliages d’aluminium, des superalliages, des composites à matrice métallique ...en fonction des traitements thermiques et thermomécaniques

# Compétences visées

* Identifier les relations compositions-microstructures-propriétés, en vue de les mettre en œuvre pour développer ou améliorer un matériau métallique, en intégrant les aspects contrainte et déformation
* Comprendre un procédé afin de prévenir l’occurrence de défauts et optimiser les propriétés, voire d'optimiser la production, voire de concevoir de nouveaux procédés.
* Concevoir, définir les tâches et réaliser des travaux de recherche et développement de nouveaux produits et de nouveaux procédés pour la métallurgie
* Mobiliser des savoirs hautement spécialisés, dont certains sont à l’avant-garde du savoir dans un domaine de travail ou d’études, comme base d’une pensée originale
* Développer une conscience critique des savoirs dans un domaine et/ou à l’interface de plusieurs domaines
* Apporter des contributions novatrices dans le cadre d’échanges de haut niveau, et dans les contextes internationaux
* Conduire une analyse réflexive et distanciée prenant en compte les enjeux, les problématiques et la complexité d’une demande ou d’une situation afin de proposer des solutions adaptées et/ou innovantes en respect des évolutions de la règlementation
* Identifier, sélectionner et analyser avec esprit critique diverses ressources spécialisées

pour documenter un sujet et synthétiser ces données en vue de leur exploitation

**Nom complet de l’UE : UE904 Métallurgie Numérique**

Composante de rattachement : Faculté des Sciences et Technologies

Nom du responsable de l’UE et adresse électronique : Benoît Appolaire [benoit.appolaire@univ-lorraine.fr](mailto:benoit.appolaire@univ-lorraine.fr)

Semestre : 9

Volume horaire enseigné : 30 heures, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l’étudiant : 45 heures

Langue d’enseignement de l’UE : Français

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| --- | --- | --- | --- | --- | --- |
| Enseignements composant l’UE | CNU | CM | TD | TP | EqTD |
| Métallurgie Numérique | **33** | 15 | 15 |  | 37,5 |

# Descriptif

Calcul de diagrammes de phases : principes de la méthode Calphad ; utilisation du logiciel ThermoCalc. Cinétiques de transformation de phases : principes des modèles de germination-croissance ; utilisation d’un code de précipitation. Solidification : principes des modèles de solidification des pièces industrielles pour la prédiction des structures et des macroségrégations chimiques ; utilisation du code Solid. Traitement thermique : utilisation d'un code de calcul couplé thermique-métallurgie-mécanique pour la prévision des microstructures, contraintes résiduelles et distortions.

# Pré-requis

Connaissances en thermodynamique, solidification, transformations de phases à l'état solide,

loi de comportement des matériaux

# Acquis d'apprentissage

Connaître des codes de calcul de diagrammes de phases, de solidification, de cinétique de transformation de phases, de contraintes et déformations résiduelles et les bases des modèles sous-jacents - analyser les hypothèses et jeux de données d’entrée - analyser les résultats avec un regard critique.

# Compétences visées

* Identifier les usages numériques et les impacts de leur évolution sur le ou les domaines concernés par la mention
* Se servir de façon autonome des outils numériques avancés pour un ou plusieurs métiers ou secteurs de recherche du domaine
* Mobiliser des savoirs hautement spécialisés, dont certains sont à l’avant-garde du savoir dans un domaine de travail ou d’études, comme base d’une pensée originale
* Développer une conscience critique des savoirs dans un domaine et/ou à l’interface de plusieurs domaines
* Apporter des contributions novatrices dans le cadre d’échanges de haut niveau, et dans les contextes internationaux
* Identifier, sélectionner et analyser avec esprit critique diverses ressources spécialisées

pour documenter un sujet et synthétiser ces données en vue de leur exploitation.

**Nom complet de l’UE : UE906 Méthodes d’analyses en métallurgie**

Composante de rattachement : Faculté des Sciences et Technologies

Nom du responsable de l’UE et adresse électronique : Stéphane Mathieu [stephane.mathieu@univ-lorraine.fr](mailto:stephane.mathieu@univ-lorraine.fr)

Semestre : 9

Volume horaire enseigné : 30 heures, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l’étudiant : 45 heures

Langue d’enseignement de l’UE : Français

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| --- | --- | --- | --- | --- | --- |
| Enseignements composant l’UE | CNU | CM | TD | TP | EqTD |
| Caractérisations microstructurale et chimique par Sonde électronique | **33** | 6 | 4 |  | 13 |
| Diffraction électronique (MET et EBSD) | **33** | 14 | 6 |  | 27 |

# Descriptif

Principes de microscopies électroniques et de microanalyses X (Interaction rayonnement/matière ; détecteurs ; limitations physiques; Spectroscopie à dispersion d'énergie (EDS) et de longueur d'onde (WDS) ; Microsonde électronique de Castaing ; Corrections ZAF.

Rappel de cristallographie géométrique et projection stéréographique, Théorie de la diffraction électronique, diffraction des électrons rétrodiffusés (EBSD), microscopies à balayage et détecteurs, préparation des échantillons.

# Pré-requis

Connaissances de base en science des matériaux (Cristallographie, structures cristallines et

défauts)

# Acquis d'apprentissage

L'objectif général du cours est de rendre les étudiants capables de caractériser la microstructure d'un matériau en utilisant de manière combinée les techniques de microscopie et de diffraction électroniques.

Cette compétence permettra à l'étudiant de choisir de manière critique les outils nécessaires à la caractérisation des matériaux métalliques, à comprendre et analyser les résultats relatifs à ces techniques présentées dans la littérature scientifique et technique.

# Compétences visées

* Mobiliser des savoirs hautement spécialisés, dont certains sont à l’avant-garde du savoir dans un domaine de travail ou d’études, comme base d’une pensée originale
* Développer une conscience critique des savoirs dans un domaine et/ou à l’interface de plusieurs domaines
* Conduire une analyse réflexive et distanciée prenant en compte les enjeux, les problématiques et la complexité d’une demande ou d’une situation afin de proposer des solutions adaptées et/ou innovantes en respect des évolutions de la règlementation
* Savoir choisir les moyens de caractérisation permettant l'analyse thermique, mécanique, structurale, microstructurale et chimique des matériaux : Quel outil j'utilise? à quelle fin je réalise cet essai en particulier ?
* Capacité à analyser des résultats expérimentaux, à en faire la synthèse avec un regard critique sur leur validité, connaissant les limites physiques de ces

**Nom complet de l’UE : UE903 Génie des procédés métallurgiques**

Composante de rattachement : Faculté des Sciences et Technologies

Nom du responsable de l’UE et adresse électronique : Thibault Quatravaux [thibault.quatravaux@univ-lorraine.fr](mailto:thibault.quatravaux@univ-lorraine.fr)

Semestre : 9

Volume horaire enseigné : 60 heures, Nombre de crédits ECTS : 4

Volume horaire travail personnel de l’étudiant : 60 heures

Langue d’enseignement de l’UE : Français

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| Enseignements composant l’UE | CNU | CM | TD | TP | EqTD |
| Génie des procédés métallurgiques | **33** | 21 |  |  | 31,5 |
| Filières métallurgiques | **33** | 9 |  |  | 13,5 |
| Soudage | **33** | 30 |  |  | 45 |

# Descriptif

Méthodologie du génie des procédés d’élaboration : Introduction, spécificités du génie des procédés d’élaboration, importance de la relation propriétés-structure-procédés. Approche systémique. Bilans globaux sur les systèmes fermés/ouverts, statiques/dynamiques, application aux bilans de matière et d’énergie en métallurgie. Bilans locaux, équations de conservation de la matière et de l’énergie, lois phénoménologiques de la diffusion, analogie électrique. Application au transfert de matière par diffusion et au transfert de chaleur par conduction. Transport de matière couplé par convection et diffusion. Mécanismes du transport par diffusion dans les gaz, les liquides et les solides, méthodes de résolution. Réactions chimiques homogènes et hétérogènes, cas des réactions gaz-solide.

Filières métallurgiques : Elaboration de l’aluminium ; étude de cas : réduction de l’hydrogène dissous et élimination des inclusions par flottation. Elaboration de l’acier. Filières fonte et électrique ; fonctionnement du haut fourneau ; étude de cas : bilans matières et équilibres dans un haut fourneau, réduction des émissions de CO2. Elaboration du zirconium et du titane ; étude de cas : comportement des défauts hard-alpha en refusion BE. Pédagogie : Tous les cours seront accompagnés d’exercices ou d’études de cas mettant en pratique les concepts introduits.

Soudage et Usinage : - Procédés de Soudage (soudage à l'arc, soudage par faisceau

laser et par faisceau d'électrons) - Soudage des aciers de construction, des aciers inoxydables, des fontes - Soudage des alliages d'aluminium - Conséquences métallurgiques et mécaniques du soudage - Contrôle non destructif des assemblages soudés - Comportement mécanique (fatigue) des assemblages soudés – Brasage - Introduction à l'usinage. Procédés et conséquences métallurgiques et mécaniques pour l’outil et pour la pièce usinée

# Pré-requis

Thermodynamique, structure des métaux et alliages. Connaissances en métallurgie et

mécanique.

# Acquis d'apprentissage

Appréhender l’importance de l’étape d’élaboration sur les propriétés des matériaux. Utiliser

les concepts du génie des procédés pour maîtriser les procédés d’élaboration, en particulier

sur les aspects cinétiques.

Connaître les grandes filières d’élaboration des alliages métalliques, y compris dans leurs

aspects les plus actuels (recyclage, coût énergétique, impact environnemental). Comprendre pour deux types de procédés comment interviennent les couplages thermique – microstructures - mécanique (étudiées dans d'autres cours) et quelles sont les conséquences sur les propriétés finales des produits.

# Compétences visées

* Comprendre un procédé afin de prévenir l’occurrence de défauts et optimiser les propriétés, voire d'optimiser la production, voire de concevoir de nouveaux procédés.
* Concevoir, définir les tâches et réaliser des travaux de recherche et développement de nouveaux produits et de nouveaux procédés pour la métallurgie
* Mobiliser des savoirs hautement spécialisés, dont certains sont à l’avant-garde du savoir dans un domaine de travail ou d’études, comme base d’une pensée originale
* Développer une conscience critique des savoirs dans un domaine et/ou à l’interface de plusieurs domaines
* Apporter des contributions novatrices dans le cadre d’échanges de haut niveau, et dans les contextes internationaux
* Conduire une analyse réflexive et distanciée prenant en compte les enjeux, les problématiques et la complexité d’une demande ou d’une situation afin de proposer des solutions adaptées et/ou innovantes en respect des évolutions de la règlementation
* Identifier, sélectionner et analyser avec esprit critique diverses ressources spécialisées

pour documenter un sujet et synthétiser ces données en vue de leur exploitation

**Nom complet de l’UE : UE905 Interactions Contraintes – Transformation de phases**

Composante de rattachement : Faculté des Sciences et Technologies

Nom du responsable de l’UE et adresse électronique : Benoît Appolaire [benoit.appolaire@univ-lorraine.fr](mailto:benoit.appolaire@univ-lorraine.fr)

Semestre : 9

Volume horaire enseigné : 30 heures, Nombre de crédits ECTS : 3

Volume horaire travail personnel de l’étudiant : 45 heures

Langue d’enseignement de l’UE : Français

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| Enseignements composant l’UE | CNU | CM | TD | TP | EqTD |
| Métallurgie Numérique | **33** | 30 |  |  | 45 |

# Descriptif

Analyse des interactions contraintes - transformations de phases - Effet des contraintes

sur les équilibres entre phases, sur la germination, sur la croissance et sur les microstructures (Cas de la précipitation cohérente, des transformations par diffusion et transformation martensitique d’alliages métalliques) - Conséquences sur le comportement mécanique au cours de la transformation de phases - Mécanismes de plasticité de transformation – Modélisation de la plasticité de transformation – Prise en compte dans les calculs de genèse des contraintes internes et des déformations au cours des traitements thermiques.

# Pré-requis

connaissances en transformations de phases à l'état solide et bases en mécanique des matériaux

# Acquis d'apprentissage

Comprendre les mécanismes des interactions contrainte - transformations de phases et connaître les bases de leur modélisation - comprendre comment ces interactions interviennent dans les procédés de traitement thermique ou de soudage des alliages métalliques

# Compétences visées

* Identifier les relations compositions-microstructures-propriétés, en vue de les mettre en œuvre pour développer ou améliorer un matériau métallique, en intégrant les aspects contrainte et déformation
* Comprendre un procédé afin de prévenir l’occurrence de défauts et optimiser les propriétés, voire d'optimiser la production, voire de concevoir de nouveaux procédés.
* Mobiliser des savoirs hautement spécialisés, dont certains sont à l’avant-garde du savoir dans un domaine de travail ou d’études, comme base d’une pensée originale
* Développer une conscience critique des savoirs dans un domaine et/ou à l’interface de plusieurs domaines
* Apporter des contributions novatrices dans le cadre d’échanges de haut niveau, et dans les contextes internationaux
* Conduire une analyse réflexive et distanciée prenant en compte les enjeux, les problématiques et la complexité d’une demande ou d’une situation afin de proposer des solutions adaptées et/ou innovantes en respect des évolutions de la règlementation
* Identifier, sélectionner et analyser avec esprit critique diverses ressources spécialisées

pour documenter un sujet et synthétiser ces données en vue de leur exploitation

**Nom complet de l’UE : Design des matériaux**

Composante de rattachement : Sciences et technologies

Nom du responsable de l’UE et adresse électronique : Fabien CAPON, Patrice BERTHOD

[fabien.capon@univ-lorraine.fr](mailto:fabien.capon@univ-lorraine.fr), [patrice.berthod@univ-lorraine.fr](mailto:patrice.berthod@univ-lorraine.fr),

Semestre : 09

Volume horaire enseigné : 50 heures, Nombre de crédits ECTS : 5

Volume horaire travail personnel de l’étudiant : 70 heures

Langue d’enseignement de l’UE : Français (Anglais possible)

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| Enseignements composant l’UE | CNU | CM | TP | EqTD |
| Couches minces et revêtements | 33 | 21 | 12 | 30 |
| Propriétés mécaniques des matériaux à haute températures | 33 | 14 | 6 | 0 |

# Descriptif

Dépôt par voie Physique PVD (Pulvérisation cathodique, EJM, Evaporation par Arc, Ablation Laser) et traitement des surfaces par nitruration ionique

Plasma froid, Synthèse des substrats, Interfaces, Techniques et modes de croissance, Morphologie des dépôts (Diagramme de Thornton)…

Notions de base de mécanique du solide et de mécanique des matériaux

Inventaire des matériaux actuels utilisables à haute température (métalliques et céramiques) et données essentielles sur leurs fabrications et leurs microstructures

Influence des hautes températures sur le comportement mécanique général des matériaux

Le fluage : description macro et micro du phénomène, dislocations et diffusion, méthode de Larson-Miller et exploitation des abaques

Rôle de la microstructure dans la résistance mécanique à haute température, choix microstructuraux et d’élaboration pour optimiser le comportement et la durée de vie des composants en service à haute température (famille de matériaux, composition chimique, mode de mise en forme, traitements thermiques …) ; interactions possibles entre comportement mécaniques et détérioration de surface en cas d’environnement chaud chimiquement agressif

Nouveaux matériaux actuellement en cours de développement et pouvant être disponibles dans un futur proche pour les applications à haute température

# Pré-requis

Connaissances de base en physique et matériaux

Notions de chimie du solide (composition chimique, réseaux cristallins, microstructures)

Vocabulaire basique de mécanique et signification (notions de force, contrainte, déformation …)

# Acquis d'apprentissage

L’objectif de ce cours est de présenter aux étudiants les défis et les nouveaux développements scientifiques et technologiques dans le domaine de l’ingénierie de surfaces, en particulier la synthèse et les propriétés des couches minces et des revêtements utilisés dans les applications de pointe. Ce cours donnera une solide base de connaissances des propriétés et de la méthodologie de mesures nécessaires pour la conception, la fabrication et la caractérisation de systèmes et de dispositifs en couches minces.

Connaissance du comportement mécanique des matériaux à haute températures et des modes de fabrication, compositions chimiques et microstructures à privilégier pour des utilisations à haute température

Connaissance des possibilités d’amélioration du comportement pour allongement de la durée de vie du matériau ou d’augmentation de la température de service en vue d’amélioration des performances et rendement

# Compétences visées

L’étudiant sera en mesure de :

- identifier les processus physico-chimiques impliqués dans la fabrication des couches minces, y compris les techniques et procédés les plus récents ;

- identifier les principes des techniques de diagnostic utilisés lors de la fabrication de couches minces et pouvoir juger leurs avantages et limitations ;

- concevoir des systèmes ayant une microstructure contrôlée à l’échelle nanométrique et d’évaluer leur performance, en se basant sur la compréhension des techniques de caractérisation

- utiliser son sens critique pour juger de la pertinence de différentes techniques de fabrication et de différents matériaux pour leur utilisation dans des applications et dispositifs avancés.

Anticiper les phénomènes de déformation et d’endommagement mécanique (sans ou avec couplage simultané avec une dégradation chimique) lors de l’utilisation des matériaux à haute température

Savoir choisir le bon type de matériau et en adapter éventuellement le mode de fabrication, la composition chimique et la microstructure pour de plus grandes efficacité et longévité en service

Etre informé des nouveaux matériaux à haute résistance mécanique à chaud potentiellement disponibles dans la prochaine décennie.