CU 9.5: CHARACTERISATION AND DEVELOPMENT OF MATERIALS

Director of studies: Alain CELZARD

General CU objectives:

- Know how to characterise a material at different scales
- Check the quality of a material
- Be able to solve problems with new material solutions
- Know how to use different families of materials
- Experimental characterisation of materials I: composition and structure

This module will aim to examine and control materials in terms of their chemical composition and structure. Chemical, thermal, and spectroscopic analysis methods, as well as porosimetry measurements and non-destructive testing techniques that enable microscopic characterization of materials, will be among the solutions presented.

- Experimental characterisation of materials II: physical properties

The lessons offered in this module will aim to determine the thermal and mechanical properties of materials, its properties of resistance to ageing, water and fire. The methods and case studies presented will therefore concern the macroscopic dimension of the materials.

- Traditional materials associated with timber constructions

This module will present the main specificities and properties of the materials used in association with timber. The major families of materials (metals, concretes, glasses, plastics, other bio-based materials) and their interactions in service will be presented.

- Organic matrix composite materials

The large family of organic matrix composites including non-woven composites will be presented here. The characteristics such as the shaping of the polymers, the main reinforcements used and the manufacturing processes of the composites will be developed.

Consists of:

- Part 1: Experimental characterisation of materials I: composition and structure
- Part 2: Experimental characterisation of materials II: physical properties
- Part 3: Traditional materials associated with timber constructions
- Part 4: Organic matrix composite materials

Hourly volume

In-person		*Self-directed study*
29.00 H	**Lectures**	**50.00 H**
48.00 H	**Tutorials**	
16.00 H	**Practicals**	

Positioning of the CU in the School reference system:

after semester 8

Units of skills

In accordance with the RNCP sheet

Updated on 21 March 2025

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Part 1: Experimental characterisation of materials I: composition and structure	**Coefficient 1**
Session leaders: Alain CELZARD	
Teaching assistants:	
Prerequisites: CU 5.3, CU 5.4	
Teaching materials: Course notes – Presentation slides	
Assessment methods: individual Class assignment	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
To be able to determine the composition of a material and characterise it in terms of chemical structure, texture, porosity and morphology. Know how to choose the most relevant technique to determine and quantify a given macroscopic characteristic.	Immediate and basic analyses	1.00	1.00	
	Properties of material surfaces	1.00	1.00	
	Determination of porosity and a specific surface	1.00	1.00	
	Chromatographic separations and analyses	1.75		
	Spectroscopic analyses	1.00	1.00	
	Non-destructive analyses and checks	1.00	1.00	
	Electron microscopy and diffractometric techniques	1.00	1.00	
	Practical exercises and laboratory demonstrations		6.00	4.00
		7.75	**12.00**	**4.00**

CU 9.5: CHARACTERISATION AND DEVELOPMENT OF MATERIALS

Part 2: Experimental characterisation of materials II: physical properties	**Coefficient 1**
Session leaders: Alain CELZARD	
Teaching assistants:	
Prerequisites: CU 5.3, CU 5.4, CU 6.3, CU 6.4	
Teaching materials: Course notes – Presentation slides	
Assessment methods: individual Class assignment	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
To be able to determine the main physical properties of materials, the major causes of their ageing and degradation, and to be able to estimate their life span. Know how to choose the most relevant technique to determine and quantify a given macroscopic characteristic.	Thermal analysis and reactivity of materials	1.00	2.00	
	Determination of mechanical properties	1.75	1.00	
	Measurement of thermal properties	1.75	2.00	
	Ageing, degradation and life span of materials	1.75	2.00	
	Water and fire resistance	1.00	1.00	
	Practical exercises and laboratory demonstrations		4.00	4.00
		7.25	**12.00**	**4.00**

CU 9.5: CHARACTERISATION AND DEVELOPMENT OF MATERIALS

Part 3: Traditional materials associated with timber constructions	**Coefficient 1**
Session leaders: Sabesan THAVAGUNASEELAN (ROLEX), Alain CELZARD	
Teaching assistants:	
Prerequisites: CU 5.1, CU 7.2	
Teaching materials: Course notes – Presentation slides	
Assessment methods: individual Class assignment	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
Know the basic specificities of the main families of materials associated with timber. Understand how to combine them to get the best performance.	Main characteristics of metal materials	1.75		
	Implementation and properties of concretes and ceramics	1.75		
	Specificities of resins, plastics and composites	1.75		
	Other current bio-based materials	1.75		
	In-service interactions and best practices for connecting them		8.00	
	Case studies		8.00	
		7.00	**16.00**	**0.00**

CU 9.5: CHARACTERISATION AND DEVELOPMENT OF MATERIALS

Part 4: Organic matrix composite materials	**Coefficient 1**
Session leaders: Raphaël KUENY (CETELOR), Nicolas VANÇON (TEMCA)	
Teaching assistants:	
Prerequisites: CU 5.3, CU 5.4, CU 9.1	
Teaching materials: Course notes – Presentation slides	
Assessment methods: individual Class assignment– Practical examination	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
Understand the strengths and limitations of plastic and resin-based materials Know the appropriate method for producing a part of given morphology and functionality. Choose a reinforcement and formatting adapted to the desired properties. Know the main markets and outlets for composites	Main polymer shaping methods: thermoplastic and thermosetting	1.75	4.00	
	Main reinforcements for organic matrix composites– specific features of natural / synthetic fibres	1.75		
	Preparation of fibrous-reinforced composites, continuous or not	1.75		4.00
	Physical properties and composite applications	1.75	4.00	
	Composites workshop tour and demonstrations			4.00
		7.00	**8.00**	**8.00**