1A FISA	CU 5.4
Semester 5	5 School ECTS - 0 Company ECTS

CU 5.4: FUNDAMENTALS OF MATERIALS AND ENERGY

Director of studies: Alain CELZARD

General CU objectives:

Give all the necessary knowledge to address in the rest of the curriculum the questions of:

- chemical and physical transformations (materials for construction and insulation, energy storage and conversion, for energy efficiency and the environment, for packaging and transport, ...)
- transfers of material and energy (heat and humidity, material and energy balances, etc.)
- associated processes (material recovery and energy recovery of biomass, drying, renewable energies, biorefinery, etc.)
- Handle and apply concepts of matter and energy to simple situations.

Consists of:

- Module 1: Thermodynamics and chemical kinetics
- Module 2: Humid air
- Module 3: Introduction to combustion
- Module 4: Cross-cutting project

Hourly volume

In-person	*Self-directed study*
17.75 H Lectures	**20.00 H**
50.00 H Tutorials	
0.00 H Practicals	

Positioning of the CU in the School reference system:

Semester 5 after CU 5.3

Units of skills

In accordance with the RNCP sheet

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Module 1: Thermodynamics and chemical kinetics	Coefficient 3
Session leaders: Vanessa FIERRO, Malika SAAD-SAOUD	
Teaching assistants: Christelle PERRIN	
Prerequisites: General basics of chemistry	
Teaching materials: Course notes – Presentation slides – Arche page	
Assessment methods: individual Class assignment– Tutorial examination	

Learning outcomes	Description	Number of student hours (in-person)		
		Lectures	Tutorials	Practicals
Describe the fundamentals of materials. Describe the fundamentals of energy: work/heat/temperature. Define the content and variables of a given system. Calculate the energy involved in any physical or chemical transformation. Predict the spontaneity of a transformation. Predict the evolution of a system in terms of energy and composition. Define mixtures and predict their behaviour. Determine the reaction mechanism Explain and use catalytic phenomena.	Principle 1: – Work, Heat – Status functions, Energy and Enthalpy – Heat capacities, Reaction heat – Standard quantities.	3.50		
	Principles 2 and 3: – Entropy, definition, calculation, meaning – Absolute entropy.	1.75		
	Physical and chemical balances: – Helmholtz and Gibbs Free Energy functions – Properties of the G function and chemical potential: Pure body phase balances.	3.50		
	Mixtures: – Colligative properties: boiling, melting, solubility, osmosis.	1.00		
	Kinetics: – Definition and measurement of the rate of a chemical reaction – Determination of rate laws (orders, activation energy) – Complex reactions: kinetic principles and approximations, reaction mechanisms, catalysis.	2.75		
	TUTORIALS: – Work, Heat, standard enthalpies of reaction, calorimetry – Calorimeter bomb: balance, theoretical flame temperature – Entropy calculations – Applications of Free Enthalpy: chemical reactions, phase changes – Determination of rate laws, Complex reactions		16.00	
		12.50	**16.00**	**0.00**

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Module 2: Humid air	**Coefficient 1**
Session leaders: Eric MOUGEL	
Teaching assistants:	
Prerequisites: Module 1 of CU 5.4	
Teaching materials: Presentation slides – Arche Page	
Assessment methods: individual Class assignment	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
Describe and determine the properties of humid air. Use humid air diagrams. Carry out energy and material balances on the basic humid air transformation processes.	Humid air: Properties and characterisation Simple transformation processes.	1.75		
	TUTORIALS: – Humid air properties, Simple transformations, Description and use of humid air diagrams – Sizing of humid air transformation processes/systems, Application to drying, air treatment and transfer in building envelopes.		8.00	
		1.75	**8.00**	**0.00**

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Module 3: Introduction to combustion	**Coefficient 1**
Session leaders: Pierre GIRODS	
Teaching assistants:	
Prerequisites: Module 1 of CU 5.4	
Teaching materials: Presentation slides – Arche Page	
Assessment methods: Individual Class assignment	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
Explain combustion-related phenomena. Use the basics to do the simple calculations related to combustion. Apply formulas to check the sizing of combustion appliances.	Introduction to combustion: – principles of combustion – main fuels / characteristics: specific case of solids and in particular wood – calorific value – smoke-producing, combustion potential, etc. – simple sizing of a combustion chamber	3.50		
	TUTORIALS: Application of the concepts seen in class: – fuel flow rates; – calculations of air flow rates, smoke flow rates; – determination of the composition of the fumes and the adiabatic flame temperature; – simple sizing of a combustion chamber		6.00	
		3.50	**6.00**	**0.00**

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Module 4: Cross-cutting project	Coefficient 2
Session leaders: Vanessa FIERRO	
Teaching assistants:	
Prerequisites:	
Teaching materials:	
Assessment methods: Report	

Learning outcomes	Description	Number of student hours (in-person)		
		Lectures	Tutorials	Practicals
Apply concepts of matter and energy to simple business situations. Analyse heat flow exchanges and establish an initial energy balance of the company or part of it.	Projects will be selected in the following areas: – Characterise the building's heating problems (involving quantities of heat to be determined and supplied by the combustion of wood, gas, or electrical energy consumption). – Determine pure combustion problems and check the conditions of the company. – Qualify the timber drying process carried out by the company, factoring in the humid air data and verification of the conditions used.		20.00	
		0.00	**20.00**	**0.00**

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