1A FISE	CU 5.4
Semester 5	5 School 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: Not applicable

Hourly volume

In-person	*Self-directed study*
17.75 H Lectures	**33.00 H**
30.00 H Tutorials	
20.00 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

Updated on 21 March 2025

CU 5.4: FUNDAMENTALS OF MATERIALS AND ENERGY

Module 1: Thermodynamics and chemical kinetics	**Coefficient 3**
Session leaders: Vanessa FIERRO, Vincent NICOLAS, Sergei CHERNIAK, Malika SAAD-SAOUD	
Teaching assistants: Christelle PERRIN	
Prerequisites: General basics of chemistry	
Teaching materials: Course notes – Presentation slides – Arche page	
Assessment methods: individual and in groups Class assignment– Practical 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	
	PRACTICALS: – Steam pressure – Cryometry – Standard enthalpies of reaction – Reaction kinetics			16.00

CU 5.4: FUNDAMENTALS OF MATERIALS AND ENERGY

12.50	**16.00**	**16.00**

CU 5.4: FUNDAMENTALS OF MATERIALS AND ENERGY

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**

Updated on 21 March 2025

CU 5.4: FUNDAMENTALS OF MATERIALS AND ENERGY

Module 3: Introduction to combustion	**Coefficient 1**
Session leaders: Pierre GIRODS, Vincent NICOLAS, Sergei CHERNIAK, Malika SAAD-SAOUD	
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	
	PRACTICALS: Combustion heat			4.00
		3.50	**6.00**	**4.00**