CU 6.3: MATERIAL AND ENERGY TRANSFERS

Director of studies: **Pierre GIRODS**

General CU objectives:

• Know and describe the different modes of material and energy transfer.

• Apply theoretical knowledge for modelling, sizing and characterisation of material and energy transfer systems or processes.

Consists of:

- Module 1: Notions of balances
- Module 2: Fluid mechanics
- Module 3: Heat transfers
- Module 4: Not applicable

Hourly volume

In-person		*Self-directed study*
24.50 H	**Lectures**	**74.00 H**
26.00 H	**Tutorials**	
20.00 H	**Practicals**	

Positioning of the CU in the School reference system:

Semester 6: after CU 5.4

Units of skills

In accordance with the RNCP sheet

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Module 1: Notions of balances	Coefficient 1
Session leaders: Pierre GIRODS, Alexandre SUAREZ (Practicals)	
Teaching assistants: Stéphane AUBERT, Julien LALLEMAND	
Prerequisites: mathematics (differential equations, integrals, derivatives, system of units, dimensions)	
Teaching materials: Course notes – Several application exercises	
Assessment methods: individual and in groups Class assignment– Practical examination	

Learning outcomes	Description	Number of student hours (in-person)		
		Lectures	**Tutorials**	**Practicals**
Describe the material and energy transfers in a system or process. Find the equation governing these transfers in transient and steady state. Solve the equation.	Balances: – Energy (steady-state, transient) – Energy (steady-state, transient) – Quantity of movement (steady-state, transient) – Application to the sizing of the heating needs of housing	3.50	4.00	
	"modelling the temperature change in a housing module according to the type of insulation and air renewal (single or double flow CMV)" practical			4.00
		3.50	**4.00**	**4.00**

CU 6.3: MATERIAL AND ENERGY TRANSFERS

Module 2: Fluid mechanics

Coefficient 2

Session leaders: Pierre GIRODS, Alexandre SUAREZ (Practicals)

Teaching assistants: Stéphane AUBERT, Julien LALLEMAND

Prerequisites: mathematics (differential equations, integrals, derivatives, system of units, dimensions)

Teaching materials: Course notes – Several application exercises

Assessment methods: individual and in groups
Class assignment– Practical examination

Learning outcomes	Description	Number of student hours (in-person)		
		Lectures	Tutorials	Practicals
Solve fluid static problems (calculation of forces, etc.). Describe the different flow modes and the reasons behind pressure losses. Set up a method for measuring experimental pressure losses. Analyse the results of these measurements by comparison with theoretical values. Size aeraulic (suction or air renewal) or hydraulic (heating networks)	Static fluids: – Fundamental principle of hydrostatics – Pascal's theorem – Archimedes' theorem Application to the determination of the forces on the walls of a tank and to the measurement of pressure.	1.75	2.00	
	Fluids dynamics: – Fluid definitions (Newtonian or other, real or perfect) – Perfect, real fluid flows (pressure losses, etc.) – Continuity equation, Bernoulli's theorem – Reaction (force) of a pipe crossed by a fluid Application to flow measurements and sizing of aero/hydraulic networks	7.00	6.00	
	"pressure loss measurements" and "flow rate measurements" practical			8.00
		8.75	**8.00**	**8.00**

CU 6.3: MATERIAL AND ENERGY TRANSFERS

Module 3: Heat transfers	Coefficient 2
Session leaders: Caroline SIMON, Pierre GIRODS, Eliott GAUTHEY FRANET (Tutorials), Alexandre SUAREZ (Practicals)	
Teaching assistants: Stéphane AUBERT, Julien LALLEMAND	
Prerequisites: mathematics (differential equations, integrals, derivatives, system of units, dimensions)	
Teaching materials: Course notes – Several application exercises	
Assessment methods: Individual and in groups Class assignment– Practical examination	

Learning outcomes	Description	Number of student hours (in-person)		
		Lectures	Tutorials	Practicals
Describe the different modes of heat transfer. Determine heat exchanges through walls or pipes (simple cases in steady state). Explain the impact of taking into account the transitional state. Size a heat exchanger	Conduction: – general principle; – reference equation; – examples and importance	1.75		
	Convection: – forced convection/natural convection – reference equations for calculations; – applications to general cases	3.50		
	Conduction/convection coupling: – balance of the transfer modes; – examples of walls & pipes	1.75	14.00	
	Radiation: – general principle & importance; – calculations for black bodies; – balances in concrete examples; – application to grey bodies.	3.50		
	Application to heat exchangers	1.75		
	Practicals: – Thermal conductivity measurement; – Study of a coaxial co-current and counter-current cylindrical heat exchanger.			8.00
		12.25	**14.00**	**8.00**

CU “CU”: “Name”