CU 9.7: STRUCTURE SIZING

Director of studies: Mourad KHELIFA

General CU objectives:

The aim is to introduce engineering students to the calculation of different structures in Civil Engineering according to the regulatory texts specific to each type of construction (reinforced concrete, metal framework, timber).

This module focuses on the diversity of computational possibilities offered by the Eurocodes (2, 3 and 5 and 8) and their respective implementation terms.

Principles and calculation methods will be developed from practical examples: braced structures with articulated assemblies, semi-rigid assemblies, timber-concrete composite beams, seismic behaviour, choice of type of foundations, bending as well as "materials" aspects and choice of materials.

Consists of:

- Part 1: Eurocode 5– Calculation of assemblies
- Part 2: Sizing of steel structures according to Eurocode 3
- Part 3: Eurocode 2 and concrete foundations
- Part 4: Seismic calculations according to Eurocode 8

Hourly volume

In-person		*Self-directed study*
28.00 H	**Lectures**	**50.00 H**
64.00 H	**Tutorials**	
0.00 H	**Practicals**	

Positioning of the CU in the School reference system:

after semester 8

Units of skills

In accordance with the RNCP sheet

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Part 1: Eurocode 5– Calculation of assemblies	Coefficient 1
Session leaders: Clément CLAUDEL (CRITTBois), Rémi SENNEPIN (CRITTBois)	
Teaching assistants:	
Prerequisites: Mechanics of Materials, Timber structure sizing according to EC5	
Teaching materials: Course notes – Reading list	
Assessment methods: individual Class assignment– Practical examination	

Learning outcomes	Description	Number of student hours (in-person)		
		Lectures	Tutorials	Practicals
Learn how to size assemblies commonly used in timber structures. Master the justification method for notched joints and mortise-and-tenon joints. Then, rod-based assemblies such as nails, staples, bolts, dowels, and lag screws, along with possible reinforcements like clamps and rings. Know the new additions to the CB 71 rules, the risks of block breakage and splitting breakage.	After a few brief reminders of the strength of the materials, and generalities concerning the evaluation of the stresses and characteristics of the materials (timber and steel), the following points will be discussed:	**1.75**		
	– Definition of assemblies by direct or notched contact. The majority of these assemblies include forked joints, notched joints, mortise-and-tenon joints and dovetails.		**4.00**	
	– Definition of rod assemblies. Rods are slender metal parts such as spikes, staples, bolts, pins or lag screws, etc. Each type of rod has specific characteristics such as penetration conditions, local bearing capacity, clamping conditions, etc. All these elements will be described in detail. BA382	**1.75**	**6.00**	
	– Definition of spike assemblies. Most of these types of assembly are timber-timber or timber-panel assemblies derived from timber.	**1.75**		
	– Applications solved on real cases (truss, crown, bracing element, etc.)	**1.75**	**6.00**	
		7.00	**16.00**	**0.00**

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Part 2: Sizing of steel structures according to Eurocode 3	**Coefficient 1**
Session leaders: Mourad KHELIFA	
Teaching assistants:	
Prerequisites: Mechanics of Materials	
Teaching materials: Course notes – Presentation slides	
Assessment methods: individual Class assignment– Report	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
Acquire the basic knowledge necessary for the calculations of metal structures according to Eurocode 3. Be able of sizing the structural elements making up an industrial building such as gantries, bracing, purlins, stringers and joists. Be able to check fasteners by bolts or welds. Master the sizing of the ground fasteners by anchoring rods.	Review of steel material, steel products, residual stresses resulting from rolling, heat treatments, destructive and non-destructive steel inspection tests, mechanical tensile tests. The characteristics of standardised profiles used in metal framing will be studied.	1.75		
	– Elastic instability phenomena (buckling, lateral-torsional buckling, warping), which significantly amplify stresses in steel members, will be addressed. – Sizing of a metal beam under simple stresses (bending, compression, tension and shearing) and under compound stresses.	1.75	4.00	
	– Learn how to check: bolted and welded assemblies, the operation of an assembly, the constructive precautions to be taken when designing an assembly.	1.75	4.00	
	– Apply the concepts of the course on the sizing of an industrial building.	1.75	8.00	
		7.00	**16.00**	**0.00**

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Part 3: Eurocode 2 and concrete foundations	**Coefficient 1**
Session leaders: Mourad KHELIFA	
Teaching assistants:	
Prerequisites: Mechanics of Materials	
Teaching materials: Course notes – Presentation slides	
Assessment methods: individual Report	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
Acquire the basic knowledge necessary for the sizing of reinforced concrete structures according to Eurocode 2. Provide the basis for choosing the type of foundations corresponding to the building in question. Be able to estimate the drop in loads necessary for the sizing of the foundations. Learn how to size composite timber/concrete sections.	Summary review of the strength of materials, general concepts concerning the evaluation of the stresses and characteristics of steel and concrete materials, the conventional methods most used in sizing.	1.75		
	– Calculation of load transfer (principle, values of permanent and live loads, reduction of variable live loads, continuity effect on adjacent perimeter posts).	1.75		
	– Study of superficial and deep foundations. Insulated and continuous sole verification. – Combination of actions for ultimate limit state design.	1.75	4.00	
	– Verification of a floor of a T-section formed by a timber/concrete composite section.	1.75	4.00	
	– Application on a real case.		8.00	
		7.00	**16.00**	**0.00**

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Part 4: Seismic calculations according to Eurocode 8	**Coefficient 1**
Session leaders: Nicolas BARTHES (BET BARTHES, 1 day), Valéry CALVI (BET CALVI, 2 days)	
Teaching assistants:	
Prerequisites: Mechanics of Materials, Structural dynamics	
Teaching materials: Course notes – Presentation slides	
Assessment methods: individual Report - File	

Learning outcomes	**Description**	**Number of student hours (in-person)**		
		Lectures	**Tutorials**	**Practicals**
Be able to size a structure of one or more storeys under seismic action according to Eurocode 8. Be able to estimate the effort of seismic forces necessary for the verification of structures with respect to the earthquake. Be able to make a choice on the type of bracing taking into consideration seismic aspects.	Reminders on the dynamic calculation of structures (calculation of the vibrational response of a system with 1 and 2 degrees of freedom, generalisation to a system with several degrees of freedom), on practical aspects and modelling assumptions of building-type structures.	1.75	4.00	
	– Modal analysis (determination of dynamic characteristics of structures). – Study of short-term stresses, such as impact, shock and impulse.	1.75	4.00	
	– Determination of the seismic force according to EC 8. – Presentation of the lateral forces method and the spectral dynamic method.	1.75	4.00	
	– Sizing of a multi-storey structure according to EC8	1.75	4.00	
		7.00	**16.00**	**0.00**