2A FISE	CU 7.1
Semester 7	6 School ECTS

CU 7.1: MODELLING OF STRUCTURES BY FINITE ELEMENT

Director of studies: **Mourad KHELIFA**

General CU objectives:

The aim is to introduce engineering students to structural calculation using the finite element method (theoretical aspects and applications

We will present the finite element method, for the linear calculation of structures, in static and vibrational conditions.

The fields of structural mechanics, thermal science and acoustics will be covered. Structures consisting of bars, beams, plates/shells and 3D solids are studied.

The quality of finite element models will also be studied (meshing, convergence).

The ABAQUS finite element software as well as MATLAB will be used as part of the practical work.

Consists of:

- Module 1: Finite element method
- Module 2: Structural dynamics
- Module 3: Acoustics
- Module 4: Not applicable

Hourly volume

In-person		*Self-directed study*
17.50 H	**Lectures**	**18.00 H**
26.00 H	**Tutorials**	
24.00 H	**Practicals**	

Positioning of the CU in the School reference system:

after CU 6.4

Units of skills

In accordance with the RNCP sheet

Updated on 23 March 2022

CU 7.1: MODELLING OF STRUCTURES BY FINITE ELEMENT

Module 1: Finite element method	Coefficient 2
Session leaders: Mourad KHELIFA, Vincent NICOLAS	
Teaching assistants:	
Prerequisites: Mechanics of Materials, Mechanics, Materials & Design, Maths	
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
The main learnings of this module allow the engineering student to: – Choose the appropriate finite element model (bar, beam, shell, solid) to model a given structure; – Evaluate finite element results and study mesh quality and convergence – Make a critical analysis and interpretation of the results; – To propose possible changes to the models	Introduction to the finite element method – uniform tensile/compressive bar structures (finite element of 2-node bars and linear interpolation in displacements, transformation in 2 and 3D global reference frames, assembly, application of the principle of minimum total potential energy for static stresses, resolution of systems of equations, limit conditions, calculation flowchart, calculation of normal forces and stresses, validation of results); – plane beams in flexural behaviour– Euler-Bernoulli model (flexural stiffness matrix, equivalent load vector). Membrane–flexural superposition for plane beams; – 3D beams in membrane, flexural and torsion (2-node finite element with 6 degrees of freedom per node) – finite elements for planar problems (triangles, quadrilaterals). Reference elements, shape functions, detailed study of the triangular element with 3 nodes; – finite elements for 3D solids (tetrahedra, hexahedra, prisms). Detailed study of the hexahedral element with 8 nodes. – practical aspects (meshes, convergence, quality of results).	8.75	10.00	12.00
		8.75	**10.00**	**12.00**

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Module 2: Structural dynamics	Coefficient 2
Session leaders: Mourad KHELIFA	
Teaching assistants:	
Prerequisites: Mechanics of Materials, Maths	
Teaching materials: Course notes – Presentation slides – Project	
Assessment methods: individual Report - Practical examination	

Learning outcomes	Description	Number of student hours (in-person)		
		Lectures	Tutorials	Practicals
At the end of this module, students will be able to: – model and study the vibrational response of a structure (building type) – determine the dynamic characteristics (frequencies and natural modes of vibration) of a structure – process the cases of periodic and aperiodic loading.	Introduction to the linear dynamics of structures – Reminders of mathematics, rheological models and differential equations – Calculation of the vibratory response of systems with only 1 degree of freedom (1 ddl) – Calculation of the vibratory response of systems with 2 degrees of freedom (highlighting the coupling) – Generalisation to N ddl systems – Practical aspects and modelling assumptions of building structures– applications – Modal analysis (determination of dynamic characteristics of structures) – Vibratory insulation: limitation of the vibrations transmitted by the equipment to the structures (floors), limitation of the vibrations of the equipment transmitted by the vibrations of the structures – Study of short-term stresses, such as impacts, shock, impulse.	8.75	10.00	8.00
		8.75	**10.00**	**8.00**

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Module 3: Acoustics	Coefficient 1
Session leaders: Sébastien AUCHET	
Teaching assistants: Julien LALLEMAND, Stéphane AUBERT	
Prerequisites:	
Teaching materials: Course notes – Presentation slides – Project	
Assessment methods: individual Class assignment	

Learning outcomes	Description	Number of student hours (in-person)		
		Lectures	Tutorials	Practicals
At the end of the module, engineering students will be able to factor sound insulation into the design of timber buildings.	Determine the sound insulation of each wall of a dwelling using the New Acoustic Regulation (NRA). Calculate the sound insulation index R' of a composite wall from the indices of the different elements making up the wall. Estimate the reverberation time of a room from the Sabine reverberation coefficients (α) of the different reverberation surfaces of the room. Measure the insulation of a building.		6.00	4.00
		0.00	**6.00**	**4.00**