

# Energy geostructures – Civil 444

Course program – Tuesday, 08:00 – 12:00

Students registered: 19

CM1113

Lecturers: Lyesse LALOUI (LL), Elena RAVERA (ER)

Assistant: Sofie TEN BOSCH (STB)

W e e k	Date	Room	C	E	Lecturer	Content
1	18.02.25	CM1113	2		LL, ER	<p><b>Introduction to the organisation of the course</b></p> <p><b>Energy geostructures – general principles</b></p> <ul style="list-style-type: none"> <li>• Anthropogenic development and the energy question</li> <li>• Geothermal energy and geothermal systems</li> <li>• Energy geostructures</li> <li>• Application and development of energy geostructures</li> <li>• Challenges and integrated design approach</li> </ul>
				2	ER, STB	<p><b>Introduction to the practical part of the course. Explanation of the work expected by the students and methodology.</b></p>
2	25.02.25	CM1113	3		LL, ER	<p><b>Heat and mass transfer theory for energy geostructures</b></p> <ul style="list-style-type: none"> <li>• Principles and modes of heat transfer</li> <li>• Energy conservation equation</li> <li>• Initial and boundary conditions</li> <li>• Principles and modes of mass transfer</li> <li>• Mass conservation equation</li> <li>• Initial and boundary conditions for mass conservation</li> </ul>
				2	ER, STB	<p><b>Project session: hours of assistance</b></p>
3	04.03.25		3		LL, ER, STB	<p><b>Site visit – Bois 8</b></p>
4	11.03.25	-	-	-	-	<p>No class Study Program MA2 GC</p>

			2	LL, ER	<b>Analytical modelling of heat and mass transfer</b> <ul style="list-style-type: none"> <li>• Considerations about heat and mass transfer</li> <li>• Thermal resistance concept</li> <li>• Principles of heat and mass transfer in pipes</li> <li>• Time-independent analytical modelling of heat transfer</li> <li>• Time-dependent analytical modelling of heat transfer</li> </ul> <b>Exercise 1:</b> Preliminary energy design of energy piles and estimation of thermal powers involved. <b>Project session: hours of assistance</b>
5	18.03.25	CM1113	2	LL, ER	<b>Thermo-mechanical behaviour of single energy piles</b> <ul style="list-style-type: none"> <li>• Thermo-mechanical testing of single energy piles</li> <li>• Thermo-mechanical schemes for energy piles</li> <li>• Bearing capacity and vertical deformation</li> <li>• Thermo-mechanical modelling of single energy piles (Thermo-Pile)</li> </ul> <b>Delivery of exercise 1 for correction</b> <b>Exercise 2:</b> Thermo-mechanical analysis of a single energy pile <b>Project session: hours of assistance</b>
6	25.03.25	CM1113	2	LL, ER	<b>Thermo-mechanical behaviour of energy pile groups</b> <ul style="list-style-type: none"> <li>• Thermo-mechanical testing of energy pile groups</li> <li>• Thermo-mechanical modelling of energy pile groups <ul style="list-style-type: none"> <li>◦ Interaction factor method</li> <li>◦ Equivalent pier method</li> <li>◦ Load transfer method</li> </ul> </li> </ul> <b>Delivery of exercise 2 for correction</b> <b>Exercise 3:</b> Thermo-mechanical analysis of energy pile groups <b>Project session: hours of assistance</b>

8	08.04.25	CM1113	2	LL, ER 2 ER	<b>Thermo-mechanical behaviour of energy walls and tunnels (part 1 &amp; 2)</b>  <b>Delivery of exercise 3 for correction</b>  <b>Project session: hours of assistance</b>
9	15.04.25	CM1113	2	LL, ER 1 ER, STB 1 ER, STB	<b>Design of energy geostructures (part 1 &amp; 2)</b> <ul style="list-style-type: none"> <li>Existing design recommendations</li> <li>Fundamentals of performance-based design</li> </ul> <b>Exercise 4: Thermo-mechanical analysis on an energy wall</b>  <b>Project session: hours of assistance</b>
10	29.04.25	CM1113	2	LL, ER 1 ER, STB 1 ER, STB	<b>Thermal potential of sites and determination of design parameters</b> <ul style="list-style-type: none"> <li>Experimental laboratory tests</li> <li>In situ thermal response test</li> <li>Thermo-mechanical behaviour of soils and soil-concrete interfaces</li> </ul> <b>Delivery of exercise 4 for correction</b>  <b>Exercise 5: Thermal Response Test</b>  <b>Project session: hours of assistance</b>
11	06.05.25	CM1113	2	LL, ER 2 ER, STB	<b>Invited lecture by Didier Mülhauser (Marti Constructions SA)</b>  <b>Delivery of exercise 5 for correction</b>  <b>Project session: hours of assistance</b>
12	13.05.25	CM1113	2	LL, ER, STB 2 ER, STB	<b>PROJECT PRESENTATIONS</b>  <b>Project session: hours of assistance</b>
13	20.05.25	CM1113	2	ER MP 1 ER, STB	<b>Environmental and technoeconomic assessment of the technology</b>  <b>Invited lecture by Margaux Peltier (Enerdrapé)</b>  <b>Project session: hours of assistance</b>

14	27.05.25	CM1113	2	ER STB	<b>Development of energy geostructures in Europe, USA, Asia and the Middle East (GEOEG)</b> <b>Invited lecture by Sofie ten Bosch: Innosuisse project in collaboration with Amberg Engineering</b>
15	03.06.25				<b><i>No lecture</i></b> <b>Delivery of project reports for correction</b>

### **Assessment methods:**

ECTS credits allocated to this course: 4

Evaluation:	Final written exam:	45% of the final mark
	5 assigned exercises:	25% of the final mark
	Design project (group work):	30% of the final mark
		<ul style="list-style-type: none"> <li>• 20% Design project Report</li> <li>• 10% Design project Presentation</li> </ul>