

**Course offered for the Ph.D. program
in Civil, Chemical, and Environmental Engineering
Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials
a.a. 2022/2023**

(course is open for the participation of students from other Ph.D. cycles or programs)

1. Title

Metamaterials for Heat Flux Manipulation and Energy Efficiency of Buildings

2. Course Description

- Definition of metamaterials - Design of metamaterials - Invariance of the heat conduction equation under transformation.
- Transformation-based design of metamaterials - Design of metamaterials for heat flux manipulation.
- Analytical and finite element solutions for concentration, shielding, and diversion of heat flux.
- Quantitatively characterized materials - Sensitivity of macroscopic response to microstructure in the finite element method.
- Optimization-based design of metamaterials - Solution of large-scale constrained optimization problems.
- Applications to heat flux manipulation - Comparison with transformation-based solutions.
- Sensitivity of the macroscopic response to microstructure in temperature-dependent metamaterials - Metamaterials with phase-change constituents.
- Sensitivity of the macroscopic response to microstructure in transient problems
- Applications to thermal management.
- Characterization of building envelopes as cementitious-based metamaterials - Optimization of the thermal performance.
- Coupling of optimization-based metamaterial design with building energy simulation
- Optimization of the thermal performance of buildings using cementitious-based metamaterials.

3. Course Organization

Frontal lessons and practical classes in the lab.

4. Teacher

Prof. Dr. Victor Fachinotti

5. Duration and credits

20h, 4 CFU

6. Activation mode and teaching period

Period: June 2023. Frontal Lessons and practical classes

7. Deadline for registration

16th of June 2023. Application: email message to the teacher
(antonio.caggiano@unige.it)

8. Final exam

- One homework assignment that addresses a problem of interest agreed between the student and Prof. Fachinotti.