

Multiphysics Metamaterials Theory and Engineering Applications

Metamaterials are materials exhibiting unconventional physical/mechanical properties that cannot be readily found in nature. They have a foundation in electromagnetics, but at the same time they have found wide applications in several engineering acoustics/electrodynamics/mechanics disciplines. The analysis and the synthesis of such materials, often physically realized as macro-scale aggregations of micro-scale/periodic arrangements of identical unit cells, requires sophisticated modeling and design methodologies that are currently at the edge of the research.

The course aims at providing the fundamentals of multiphysics metamaterials theory and concepts, along with an overview of the most effective analysis/synthesis techniques and their most appealing/emerging applications in advanced engineering fields. Applicative examples including exercises will corroborate the theoretical concepts.

Course Topics

- Fundamentals and basic theory/concepts of multiphysics metamaterials;
- Volumetric and surface metamaterials (i.e., metasurfaces), soft/hard surfaces, periodic and quasi-periodic surfaces;
- Advanced modeling and simulation techniques for the analysis of periodic and quasi-periodic structures with a focus on Floquet modes theory;
- Advanced design techniques for the synthesis of innovative metamaterials in engineering fields;
- Applicative examples including exercises regarding specific engineering applications of multi-physics metamaterials.

Lecturers

- Prof. OLIVERI Giacomo (<https://www.eledia.org/eledia-unitn/people/oliveri-giacomo/>)
- Dr. SALUCCI Marco (<https://www.eledia.org/eledia-unitn/people/salucci-marco/>)

References

- [1] D. H. Werner and D. H. Kwon, Transformation Electromagnetics and Metamaterials, Fundamental Principles and Applications, Springer, 2014.
- [2] J. Surjadi et al., "Mechanical metamaterials and their engineering applications," Advanced Engineering Materials, vol. 21, no. 3, p. 1800864, 2019.
- [3] A. Massa and G. Oliveri, "Metamaterial-by-Design: Theory, methods, and applications to communications and sensing - Editorial," EPJ Applied Metamaterials, vol. 3, no. E1, pp. 1-3, 2016.
- [4] G. Oliveri, D. H. Werner, and A. Massa, "Reconfigurable electromagnetics through metamaterials - A review" Proc. IEEE, vol. 103, no. 7, pp. 1034-1056, Jul. 2015.

Dates: 27 June –1 July, 2022

Location

- *In presence:* Polo di Mesiano, Via Mesiano 77, 38123 Trento, Italy
- *Online:* Zoom Platform (video registrations will be available for 2 weeks after the event)

Lessons

- 32 h total (including exam – not mandatory)
- 12 h hands-on (in Matlab)

Prerequisites: Basics of Maths

ECTS: 4

Registration Fees (*)

- Free for UniTN Students
 - 200 Euro - online attendance
 - 400 Euro - in presence attendance
- Registration is mandatory

Course Coordination

- Prof. Giacomo Oliveri
- Dr. Marco Salucci

Further Information

- summer-schools@eledia.org

(*) The fees include the course teaching and the slides/material

Register at: <https://edu.eledia.org/courses/phd-school-2022-multiphysics-metamaterials>