



# M<sup>3</sup> Multifunctional Metamaterials & Metastructures

## Postgraduate Program (Master Universitario II Livello)

## Objectives of the Program

- To train professionals with skills in analysis, design, analytical and computer modeling, simulation, and experimental validation in the field of **Multifunctional Metamaterials and Metastructures**
- To address theoretical/practical issues regarding
  - Theoretical foundations** of Metamaterials and Multifunctional Metastructures in various disciplines according to the physical phenomena of interest
  - Analysis techniques** of artificial materials and methods for their functional and logical characterization in **analytical and mathematical terms**
  - Large-scale **numerical modeling techniques of complex multifunctional structures**, also considering their multi-physical properties, through multi-scale techniques on **high-performance computing (HPC)** architectures and integration of hybrid approaches based on the use of **Artificial Intelligence**
  - Realization, implementation, and experimental characterization** in labs from a mechanical, electromagnetic, and structural viewpoint of multifunctional artificial materials
  - Cross-disciplinary applications** regarding multiple relevant scenarios, including the study of metamaterials and multifunctional metastructures in the **mechanical, structural, electromagnetic, energy, environmental and marine fields**

## Grants and Opportunities

Available grant opportunities will be announced at the following page: <https://master-m3.unitn.it/grants>

## Admission Requirements

- Those in possession of one of the following qualifications can apply to participate in the Master in "Multifunctional Metamaterials and Metastructures": (i) old system degree; (ii) master's degree or single-cycle master's degree; (iii) foreign qualification (Master Degree), recognized as suitable according to current legislation
- Applications for participation in the Master's program should be submitted exclusively via online application by **January 6, 2025 @ 12:00 (CET)**. More information at: <https://master-m3.unitn.it/admission>

## The M3 Program

The Program includes a set of Standard Courses for a total of 42 ECTS (+10 ECTS of Lab Courses)

| #  | Standard Courses  | H  | ECTS |
|----|---|----|------|
| 1  | Foundations of Materials Science  | 15 | 3    |
| 2  | Foundations of Electromagnetic Waves  | 15 | 3    |
| 3  | Foundations of Mechanics and Acoustics  | 15 | 3    |
| 4  | Foundations of Waveguides Propagation   | 15 | 3    |
| 5  | Introduction to Multi-Functional Metamaterials  | 15 | 3    |
| 6  | High-Performance Computing (HPC) for Multifunctional Metamaterials and Metastructures | 15 | 3    |
| 7  | Random Vibrations and Uncertainty Quantification for Metamaterials                    | 15 | 3    |
| 8  | Analysis and Design of Linear and Nonlinear Metastructures                            | 15 | 3    |
| 9  | Dynamics and Homogenization of Periodic Metamaterials                                 | 15 | 3    |
| 10 | Advanced Modeling of Exotic Metamaterials   | 15 | 3    |
| 11 | Hydrodynamic Metamaterials for Fluid  | 15 | 3    |
| 12 | Metasurfaces and Metamaterials for Electromagnetic Wave Manipulation                  | 15 | 3    |
| 13 | Additive Manufacturing of Metasurfaces and Metamaterials (Automation and Controls)    | 15 | 3    |
| 14 | Additive Manufacturing of Metasurfaces and Metamaterials (Technologies)               | 15 | 3    |
| 15 | Topological and Mechanical Characterization of Metamaterials                          | 15 | 3    |
| 16 | Smart and Nano Metamaterials  | 15 | 3    |

2/4 Constrained Choice

Mandatory Courses

| #  | Lab Courses  | H  | ECTS |
|----|--|----|------|
| 1  | Lab on Design-based Materials Selection                            | 15 | 2    |
| 2  | Lab on AI-based Metamaterials & Metastructures Design              | 15 | 2    |
| 3  | Lab on Additive Manufacturing of Metamaterials (Part I)            | 15 | 2    |
| 4  | Lab on Additive Manufacturing of Metamaterials (Part II)           | 15 | 2    |
| 5  | Lab on Metasurface Printing/ Manufacturing                         | 15 | 2    |
| 6  | Lab on Deployable Metamaterials                                    | 15 | 2    |
| 7  | Lab on Metasurfaces for Smart Electromagnetic Environment          | 15 | 2    |
| 8  | Lab on HPC for Multi-Functional Metamaterials and Metastructures   | 15 | 2    |
| 9  | Lab on Advanced Computational Modeling of Mechanical Metamaterials | 15 | 2    |
| 10 | Lab on Product Design Fundamentals                                 | 15 | 2    |

5/10 Constrained Choice

The Courses include a combination of different teaching activities for a total of 1500 Hours

| Activity Type  | Hours       | ECTS      |
|--|-------------|-----------|
| Front lesson   | 210         | 42        |
| Individual Study related to frontal lessons, including Self-Assessment sessions    | 808         |           |
| In-depth seminars and “hot-topic” tutorials  | 32          | 0         |
| Lab activities (w/ Lab Coordinator)  | 75          | 10        |
| Individual Study related to laboratory lessons, including Self-Assessment sessions | 175         |           |
| Internship or Stage  | 150         | 6         |
| Individual activity related to the Final Exam                                      | 50          | 2         |
| <b>Total</b>   | <b>1500</b> | <b>60</b> |

## Occupations and Fields of Activity

- Companies involved in the design, development, engineering, production, and operation of artificial materials and their applications
- Industries operating in the field of **mechanical** and **electronic** technologies for **avionics** and aerospace
- Industries operating in the field of **civil and environmental engineering** technologies, in particular in the fields of **anti-seismic and acoustic, thermal, and mechanical insulation**
- Industries operating in the design and development of both **terrestrial** and **space communications** and sensing systems;
- Industries operating in the field of **automotive** and next generation **land transport systems** technologies
- Companies operating in the **biomedical field** requiring skills for the development and use of systems based on artificial multifunctional materials
- **Materials engineering** companies
- **Research and development centers**, both public and private



## Profile of the Study Program

- Degree: Postgraduate Program (Master Universitario II Livello)
- Language: English
- Duration: 1 year
- Period: Jan-Dec 2025
- ECTS: 60
- Fee: 3000 Euro

### Read More

- M3 Website: <https://master-m3.unitn.it>
- DICAM Website: <http://dicam.unitn.it>
- DII Website: <http://dii.unitn.it>
- Coordinator: Prof. Andrea MASSA



**M3** Multifunctional Metamaterials & Metastructures

### Open Ceremony: Register Now!

Register at <https://master-m3.unitn.it/opening-day> to attend the Opening Ceremony Day that will take place in hybrid format on **January 29, 2025** with Keynote Speeches of Prof. Nader ENGHETA (University of Pennsylvania) and Prof. Glaucio H. PAULINO (Princeton University).

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