**Università degli Studi di Pavia**
Laboratory of Programmable Materials and Structures (ProMaSt Lab)

INTENSIVE COURSE 2026

# Design of smart soft materials: from modeling to experimental characterization towards 4D printing

Smart soft materials are a class of soft materials whose physical properties can be controlled by a plethora of different stimuli (e.g., temperature, pH, light). Due to their unique properties these materials can be applied in numerous applications, from automotive to medical devices and robotics. This course aims at providing a practical introduction to these materials, covering both materials science and modeling/numerical aspects. In particular, focus will be given to shape memory polymers and hydrogels, analysing possible design, characterization, and fabrication strategies towards 4D printing. Application examples from various sectors—such as biomedical engineering, soft robotics, and related fields—will also be provided. Alongside, their constitutive modeling and numerical counterpart will be treated. Lectures will be complemented with "hands-on" sessions on constitutive model implementation in Matlab and a visit to the laboratory of Programmable Materials and Structures (ProMaSt Lab) to familiarize with experimental characterization facilities treated in the theoretical lectures.

## Contents:

*Day 1*: Course introduction & motivation
Continuum mechanics: review on fundamentals
Polymers: an overview

*Day 2*: Characterization of polymeric materials
Smart polymers
Shape memory polymers (SMPs)

*Day 3*: Shape memory hydrogels (SMHs)
Constitutive modeling of SMPs

*Day 4*: Matlab hands-on session
Constitutive modeling of SMHs

*Day 5*: 4D printing
Case study
Numerical methods for 4D printing

*Day 6*: ProMaSt Lab visit

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**Dates**: May 5, 7, 12, 14, 19, 21

**Time:** 11:00-13:00 and 14:00-16:00

**Classroom:** Ricciardi/MS1 room at DICAr (except May 21, ProMaSt Lab)

**SSD**: IMAT-01/A, CEAR-06/A, IBIO-01/A

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