



# PhD in MODELLI E METODI MATEMATICI PER L'INGEGNERIA / MATHEMATICAL MODELS AND METHODS IN ENGINEERING - 40th cycle

**PNRR 630 Research Field: NUMERICAL METHODS FOR DIGITAL TWINNING IN  
INDUSTRIAL APPLICATIONS**

<b>Monthly net income of PhDscholarship (max 36 months)</b>
<b>€ 1400.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

<b>Context of the research activity</b>	
<b>Motivation and objectives of the research in this field</b>	<p>The proposed research aims to explore implementing and optimizing Digital Twin technology for industrial applications, focusing on enhancing operational efficiency, predictive maintenance, and decision-making processes. As the industry increasingly adopts digital transformation strategies, Digital Twins offer a powerful tool to create virtual replicas of physical systems, processes, and assets through numerical simulations, thus enabling real-time monitoring, analysis, and control. The motivation behind this research is driven by the need to improve asset management, reduce downtime, and increase productivity through data-driven insights. The objectives include developing robust Digital Twin frameworks, integrating advanced data analytics and machine learning algorithms, and validating their effectiveness in real-world industrial environments. This research will contribute to the advancement of Industry 4.0, providing scalable and adaptable solutions that bridge the gap between physical and digital domains, ultimately leading to smarter, more efficient industrial operations. This PhD project leverages the well-established wellpetences within the MOX Lab on reduced order modelling for partial differential equations, scientific machine learning and their application to digital twins with the industrial experience of MOXOFF. It combines methodological study, algorithmic development and implementation with the application to concrete</p>



	<p>problems of industrial interest.</p> <p>Bibliography:Regazzoni, F., Pagani, S., Salvador, M., Dede', L., &amp;Quarteroni, A. (2024). Learning the intrinsic dynamics of spatio-temporal processes through Latent Dynamics Networks. Nature Communications, 15(1), 1834.Quarteroni, A., Manzoni, A., and Negri, F. Reduced basis methods for partial differential equations: an introduction, Vol. 92. (Springer, 2015)Kapteyn, M. G., Knezevic, D. J., &amp;Willcox, K. (2020). Toward predictive digital twins via component-based reduced-order models and interpretable machine learning. In AIAA scitech 2020 forum (p. 0418).</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<ol style="list-style-type: none"> <li>1. Study of reduced model methods suitable for Digital twin development.</li> <li>2. Identification of Initial Case Studies.</li> <li>3. Implementation, analysis and validation of initial prototype.</li> <li>4. Identification of Industrial Application.</li> <li>5. Simulation and Modelling.</li> <li>5. Final Validation and Testing.</li> <li>6. User Interface Development (optional).</li> </ol>
<p><b>Educational objectives</b></p>	<p>Besides the skills acquired by following the PhD courses by the PhD school, the student will acquire a deep expertise in Digital Twin technology, advanced data analytics, and industrial systems engineering. Additionally, the project seeks to enhance the ability to translate theoretical knowledge into practical, impactful industrial applications.</p>
<p><b>Job opportunities</b></p>	<p>Graduates of this PhD project will have diverse job opportunities in manufacturing, aerospace, automotive, energy, and smart infrastructure sectors. They can pursue roles like Digital Twin Engineer, Industrial IoT Specialist, Data Scientist, Predictive Maintenance Analyst, and Industry 4.0 Consultant. Additionally, opportunities in academic and research institutions for teaching and research in digital transformation and industrial automation could be pursued.</p>



<b>Composition of the research group</b>	1 Full Professors 3 Associated Professors 2 Assistant Professors 1 PhD Students
<b>Name of the research directors</b>	Luca Dedè, Luca Formaggia Luigi Simeone (MOXOFF)

<b>Contacts</b>	
<i>luca.formaggia@polimi.it,</i> <i>luca.dede@polimi.it</i> <i>luigi.simeano@moxoff.it</i>	

<b>Additional support - Financial aid per PhD student per year (gross amount)</b>	
<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents (more than 80Km out of Milano)</b>	--

<b>Scholarship Increase for a period abroad</b>	
<b>Amount monthly</b>	700.0 €
<b>By number of months</b>	6

<b>National Operational Program for Research and Innovation</b>	
<b>Company where the candidate will attend the stage (name and brief description)</b>	MOXOFF
<b>By number of months at the company</b>	6
<b>Institution or company where the candidate will spend the period abroad (name and brief description)</b>	
<b>By number of months abroad</b>	6

<b>Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information</b>
<p>Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per year</p> <p>1st year: max 1.902,40 euros                      2nd year: max 1.902,40 euros                      3rd year: max 1.902,40 euros</p> <p>The PhD students are encouraged to take part in activities related to teaching within the limits allowed by the regulations. He will be provided with a work solace equipped with 1 individual PC and granted access to the Departmental high performance facilities (HPC cluster).</p>