POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

INTERDISCIPLINARY Research Field: DEVELOPMENT OF COMBINED PHYSICAL AND DIGITAL TWINS OF THE HUMAN BODY

Monthly net income of PhDscholarship (max 36 months)
1500.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Interdisciplinary PhD Grant The PhD research will be carried out in collaboration with research groups of the PhD programme in "**MATHEMATICAL MODELS AND METHODS IN ENGINEERING**". See https://www.dottorato.polimi.it/?id=422&L=1 for further information. Digital twins of human organs are computational models that enable the study of disease evolution, deepen knowledge about a specific disease, and facilitate the development of personalized treatments. At the same time, there is a growing interest in creating realistic physical replicas of humans' organs, exploiting the potential of additive manufacturing technologies. These artificial physical replicas are used for preoperative planning and training purposes, but they can also work as testing setups for the development of new devices or procedures. This research aims to bridge these two fields of investigation to promote, among others, a more advanced testing of therapies and/or medical devices.
Methods and techniques that will be developed and used to carry out the research	A combination of computational and experimental methods and techniques will be applied and further elaborated to carry out the research activity. For example, mathematical and numerical approaches will be used to develop the digital model, while additive manufacturing technologies will be exploited for the physical model. The

	technologies will be exploited for the physical model. The developed solutions will also be characterized and validated experimentally.
Educational objectives	The doctoral student will be part of a highly multidisciplinary research environment that bridges topics in mechanical engineering with mathematical models and methods, as well as competencies in the biomedical/medical field. Therefore, the candidate will develop the capability to apply and further develop up-to-date knowledge and methodologies in the field of mathematical modelling for engineering, engineering design methods and tools, experimental mechanics, additive manufacturing, and the development of biomedical/medical applications, among others. Additionally, the candidate will develop soft skills related to scientific presentations, publication writing, and drafting of research proposals.
Job opportunities	There is a growing interest in developing digital twins across multiple sectors. In parallel, additive manufacturing technologies are now transforming the manufacturing landscape. The biomedical /medical industry is intensely involved in both technological advancements. Therefore, the proposed research field has the potential to open multiple job opportunities. In addition, the NemoLab research center (https://nemolab.it) has expressed its interest in collaborating in this research field, contributing expertise in materials science, regenerative medicine, and 3D printing, among other areas. Finally, spending a research period abroad during the PhD period, within a leading research group in the field, is strongly recommended. To this aim, the PhD candidate can benefit from the extensive international collaborations of the three research directors who have promoted this research field.
Composition of the research group	1 Full Professors 2 Associated Professors 0 Assistant Professors 0 PhD Students
Name of the research directors	Proff. S.Graziosi, M. Carboni, P. Ciarletta

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of € 6.114,50. Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 750 euro/month- net amount). Additionally, PhD candidates who spend at least 3 months abroad are eligible for an extra reimbursement of €3,000 to cover travel expenses. Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.