



PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 39th cycle

PNRR 117 Research Field: DEVELOPMENT OF A DIGITAL TWIN-BASED SIMULATION FRAMEWORK FOR A GENERATION-IV MOLTEN SALT REACTOR

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

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

Energy is today at the forefront of the World as well as of the European and Italian concerns, because of the emerging, new trilemma: global warming, strategic and geo-politic dependence, economic impact. The ecological transition is one of the key pillars of the EU policies as well as of the Italian recovery plan (PNRR). Nuclear energy represents today almost 50% of the carbon-free electricity in EU and around 10% of total electricity consumption in Italy. According also to IPCC reports, the CO₂ equivalent emissions per kWh produced for nuclear are equivalent to wind power and lower than photovoltaic. In such a framework, Generation-IV fission technologies as Molten Salt Reactor (MSR) may play an important role in generating CO₂-free, reliable and programmable energy supply in the long run. The presence of liquid fuel, i.e., a molten salt mixture, acting also as coolant, provides MSRs with a great potentiality in terms of safety, economics and sustainability. In the effort of improving the MSR operation beyond the current status, an integrated-informative framework for the plant state and reactor control is of extreme importance for enhancing the robustness and the autonomous features of the system. In this view, Digital Twins (DTs) as virtual representation of the system are under consideration as key tool not only by reactor designers but also by safety authorities (e.g., NRC). The aim of the research is then to identify the



	characteristics and the capabilities required by a MSR DT, to develop appropriate models and their integration with the data flow coming from the plant, to apply the DT to state reconstruction, informed-based decisions, autonomous control capability. The objectives of the research are in line with the topics targeted by DM 117/2023, in the Mission 4, Component 2 "From research to enterprise" (M4C2) aiming at increasing high-level skills for fulfilling the innovation needs of companies. The PhD candidate will spend at least 6 months at ThorCon, a startup which is developing a MSR.
Methods and techniques that will be developed and used to carry out the research	A comprehensive approach will be adopted, to both complement the equation-based and the data-informed modelling. The methods and techniques to be used will be mainly of numerical-modelling. Among the state-of-the-art simulation codes: SERPENT (neutronics), OpenFoam (CFD - multiphysics), MODELICA (object oriented modelling), Python (control system).
Educational objectives	The PhD candidate will develop high-qualified skills and expertise in the nuclear energy & innovative reactors area, with a focus on Molten salt reactor. In addition, the PhD candidate will be able to perform high-level research activity, especially in the industrial field to create high-skilled professionals able to satisfy the innovation need of the companies.
Job opportunities	The candidate profile will be highly attractive both in the research environment, where cross-disciplinary skills are more and more appreciated, and in the expanding field of fission energy system design, analysis, manufacturing and management.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 12 PhD Students
Name of the research directors	Stefano Lorenzi

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Research Group web site www.nuclearenergy.polimi.it

Additional support - Financial aid per PhD student per year (gross amount)

Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad

Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation

Company where the candidate will attend the stage (name and brief description)	ThorCon
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	(company, research center or university, to be agreed with ThorCon)
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities: Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc. The amount is about Euro 5700.

Teaching assistantship: Availability of funding in recognition of supporting teaching activities by the PhD student. 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.

Computer availability: individual use.

Desk availability: individual use. Accommodation in Politecnico's Residences

(<http://www.residenze.polimi.it>) is available for PhD candidates; special rates will be applied to selected out-of-town candidates (detailed info in the call for application).

Research period abroad: Our candidates are strongly encouraged (6 months minimum is mandatory) 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. 700 euro/month- net amount).