



PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 41st cycle

**INTERDISCIPLINARY Research Field: HEALTH AND USAGE MONITORING OF WIND
TURBINES AND FARMS**

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 **"INFORMATION TECHNOLOGY"**.
See <https://www.dottorato.polimi.it/?id=422&L=1> for further information.

The aim of this research is to develop a machine-learning based Health and Usage Monitoring Systems (HUMS) for generic civil structures, with a particular emphasis on offshore wind turbines. The goal is to facilitate the transition from traditional time-based to more efficient condition-based maintenance, fostering the development of a sustainable and resilient infrastructure and advancing the shift toward cleaner energy systems. Offshore turbines are ideal systems to prove the effectiveness of this HUMS due to their unique characteristics: they are often located remotely and operate in complex environments where they are affected by turbulent winds and wakes from nearby turbines. Therefore, the ability to automatically diagnose damages, detect failures and estimate fatigue over time is crucial for smart infrastructure development.

**Methods and techniques that will be
developed and used to carry out the
research**

Designing HUMS clearly requires a multidisciplinary approach, as outlined above. Specifically, knowledge of the turbine behavior from the aeromechanical sector will be integrated with expertise in artificial intelligence derived



	be integrated with expertise in artificial intelligence derived from information theory. On the one hand, it is necessary to use mathematical models that accurately simulate the behavior of real turbines and farms for generating realistic data. On the other hand, machine learning algorithms are employed for fault detection and fatigue estimation. Additionally, network theory, graph analysis, clustering methods, and advanced machine learning techniques will be explored to analyze airflow interactions between turbines within the same farm, examining wake effects and their impact on the health of neighbouring turbines.
Educational objectives	The home and host department have already established a successful collaboration, which has led to several publications and a patent on pitch misalignment detection for wind turbines through machine learning techniques. At the completion of the Ph.D. course, the candidate will have expanded detection strategy including additional failure and will have addressed the online estimation of turbine fatigue, considering the complex turbine-wake interaction in farms
Job opportunities	Due to the interdisciplinary nature of this project, the Ph.D. candidate will develop advanced expertise in both the wind energy sector and in machine learning techniques applied to fault monitoring of rotary wing systems, such as wind turbines and helicopters. Such an expertise will open up a range of career opportunities, including: - Research investigator or manager in the aeromechanical and electronic sectors - Senior aeronautical and/or electronic engineer - Researcher or engineer in the field of sustainable energy
Composition of the research group	2 Full Professors 1 Associated Professors 1 Assistant Professors 1 PhD Students
Name of the research directors	Stefano Cacciola

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
The PhD candidate will receive a desk, possibly through a hot-desking procedure, and a personal computer, if needed. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses and receive economic support to attend summer schools and participate in conferences. There will be the possibility of paid teaching assistantship.