PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 41st cycle

THEMATIC Research Field: ENHANCEMENT OF ADVANCED AIR MOBILITY AIRCRAFT PERFORMANCE THROUGH ADVANCED EXPERIMENTAL TECHNIQUES AND NUMERICAL METHODS

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	Advanced air mobility (AAM) has gained significant interest as a sustainable alternative to ground traffic. Featuring distributed electric rotors/propellers for vertical takeoff and landing, AAM vehicles offer an alternative to conventional helicopters but introduce new challenges in aerodynamics, structural dynamics, and aeroacoustics. Advancing multidisciplinary knowledge is essential to optimize their design and make them viable for next-generation air mobility. This research program aims to establish a groundbreaking synergy between advanced experimental techniques and numerical methodologies to enhance rotorcraft performance. A key focus is developing virtual sensing for real-time rotor state, shape, and load reconstruction, improving aerodynamics, structural health monitoring, flight control, and acoustic footprint, for safer and more environmentally friendly and socially acceptable air vehicles. A core objective is deploying advanced measurement techniques, including fiber-optic sensors embedded in rotor blades, supplemented by strain gauges, to measure axial and shear strains at multiple locations. These measurements will be validated in a wind tunnel, forming a comprehensive database for shape sensing, health monitoring, and state reconstruction under operational conditions. Additionally, this research will apply virtual sensing to evaluate and optimize aerodynamic loads on lifting surfaces with multiple rotors/propellers,

	characteristic of AAM aircraft. A digital twin will support the entire study, integrating high-fidelity aeromechanics analysis to assess the performance and capabilities of virtual sensing in rotorcraft systems.
Methods and techniques that will be developed and used to carry out the research	To achieve the project's objectives, aeroelastic models of rotorcraft systems will be developed and manufactured to facilitate measurements using innovative embedded optical technology. This approach enables data collection from components rotating at high angular velocities, overcoming the challenges of such an extreme environment. Wind tunnel experiments will play a crucial role in validating advanced measurement techniques and assessing rotorcraft performance improvements. Additionally, state-of-the-art aeroelastic solvers, integrating mid-fidelity aerodynamic simulations with multibody analysis, will be extensively utilized throughout the project.
Educational objectives	The objective of this PhD is to develop interdisciplinary expertise in aerodynamics and aeroelasticity. Candidates will gain proficiency in experimental techniques and numerical analysis while fostering an innovative and collaborative mindset. The program also emphasizes soft skills such as research presentation, report writing, outreach, dissemination, and progress meeting preparation. To enhance knowledge exchange, a six month research stay either in Italy or abroad may be considered, providing valuable collaboration opportunities with leading research groups in the field.
Job opportunities	The job opportunities that this project opens are in the field of design of advanced air mobility systems in the aerospace industry. The rotorcraft field is expanding at a very fast rate and it is expected that the introduction of new technologies such as the ones which will be studied in the framework of the proposed research will further enlarge the spectrum of possible applications.
Composition of the research group	1 Full Professors 3 Associated Professors 2 Assistant Professors 2 PhD Students

Name of the research directors	Prof. Alex Zanotti

Contacts
Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano - via La Masa 34, 20156 Milano - Italy - tel. +390223998323 - fax +390223998334 - email: XXX@polimi.it - web site: www.aero.polimi.it

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.