POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

Number of scholarship offered	8
Department	DIPARTIMENTO DI SCIENZE E TECNOLOGIE AEROSPAZIALI

Description of the PhD Programme

The Ph.D. course in Aerospace Engineering aims at the acquisition of the high-level competence in the aerospace field required to carry out innovative research and/or advanced applications in universities, industries, public or private research centers, service companies. The Ph.D. program gives special emphasis to the development of multi-disciplinary thinking and problem-solving skills in students, with special attention to the potential environmental and societal impact of the research, while striving to give the students a solid knowledge of the fundamental physical phenomena and of all necessary state-of-the-art methods and tools. The level of the course allows the graduates to compete in a European and international environment. Over the years, the Ph.D. students have developed research relevant to aircraft, rotorcraft, and space applications, but also to technical areas not strictly related to the aerospace field. Examples of Ph.D. thesis topics are in: Computational and experimental fluid mechanics, Aeroservoelasticity, Dynamics and Control of Aerospace Structures, Flight Mechanics and Flight Control, Passive Structural Safety of Aerospace and Non-Aerospace Vehicles, Space Missions Analysis and Planning, Innovative Materials and Structures Design and Testing, Space Propulsion, Wind Turbines, Advanced Rotorcraft Technologies, Maintenance-Based Design, Mathematical Modelling and Simulation, Airworthiness and Certification.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: ACTIVE CONTROL OF WIND TURBINES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The control of large wind turbines is an extremely challenging engineering problem due to several factors, including the need to reduce loads caused by wind turbulence and gusts, hydro-dynamic effects in off-shore applications, the need to reduce vibrations and avoid aero -elastic instabilities, and many others. Goal of the project is the development of active control methods and supporting technologies which can meet the needs of current design configurations, and that can operate in a robust and reliable manner, self-adapting to a wide range of operating conditions.
Methods and techniques that will be developed and used to carry out the research	Model-based linear and non-linear controllers, adaptive control laws which can self-adjust to varying operating conditions, Kalman-based observers of the wind turbine flexible states and of the wind states, system identification techniques.
Educational objectives	The student is expected to gain competence on the state-of-the-art of aero-servo-elastic modeling of wind energy systems, modern active control techniques and their hardware implementation.
Job opportunities	The research group works in close collaboration with several Italian and foreign companies, which are always interested in hiring engineers with specific wind energy competence and experience. Former students now work for Garrad Hassan, Vestas, Leiwind, etc.

POLITECNICO DI MILANO

Composition of the research group	0 Full Professors 1 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Alessandro Croce

Contacts
alessandro.croce@polimi.it, +39-02-2399.8322 POLI-Wind project homepage: http://www.aero.polimi.it/bottasso/POLI-Wind.htm

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: ADVANCED MATERIALS AND TECHNOLOGIES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The success of future aerospace structures will depend on their multi-functionality. Their efficiency will depend on their capability of integrating different features (e.g. structural performances, thermal endurance and morphing capabilities). Their durability will depend on the capability of self-monitoring and (possibly) self-healing. Their affordability will depend on the capability of incorporating HUMS (health and usage monitoring systems) for implementing predictive maintenance approaches. Besides, advanced process technologies should be made available for including, reliably and profitably, all these characteristics into the final product These are the general objectives in this research field and the focused targets of this specific research topic.
Methods and techniques that will be developed and used to carry out the research	The research will be carried out through a multi-tool numerical/experimental/technological philosophy, i.e. exploiting the synergy among innovative numerical approaches, up-to-date actuating/sensing strategies and advanced production technologies.
Educational objectives	To get the capability to design smart structures and assess related process techniques. To gain experience in managing multi-tools research approaches.
Job opportunities	Production process manager, senior materials scientist, senior test engineer

POLITECNICO DI MILANO

Composition of the research group	2 Full Professors 0 Associated Professors 2 Assistant Professors 2 PhD Students
Name of the research directors	G. Sala, L. Di Landro, A. Airoldi, P. Bettini

Contacts
giuseppe.sala@polimi.it (tel. +39-02-2399.8361) luca.dilandro@polimi.it (tel. +39-02-2399.8398) alessandro.airoldi@polimi.it (tel. +39-02-2399.8363) paolo.bettini@polimi.it (tel. +39-02-2399.8391)

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

THEMATIC Research Field: ADVANCED TECHNIQUES FOR FUTURE PLANETARY GLOBAL NAVIGATION SATELLITES SYSTEMS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	As the Artemis program, among other initiatives all over the world, confirms, nowadays the Space sector is programming numerous robotic and long staying manned missions towards the Moon. A long-term activities scenario on our satellite asks for developing proper infrastructures and services to support users on orbit and on the surface at the Moon; among the required services, navigation and communication relay play a prominent role. In fact, Europe and US are designing Cislunar constellations to offer positioning and data transfer services to future lunar missions. The goal of the research will be part of this scenario, aiming at designing, developing and demonstrating innovative Planetary Position, Navigation and Timing (PNT) techniques for state determination and reconstruction in the lunar environment, combining the processing techniques of traditional sensors on-board of lunar space assets, such as rovers, landers and orbital spacecraft with a properly shaped future lunar Global Navigation Satellite System (GNSS) signals. In particular, different sensors\measurements architectures available onboard the users will be assessed to address the design of the Lunar navigation system signal and the GNSS satellites constellation orbital configuration, taking into account the non-keplerian dynamics regimes the Cislunar environment offers as well. It is expected to develop a high accuracy navigation technique for planetary users by effectively fusing different signals, from onboard classical\non-

	conventional sensors and properly design the Planetary Navigation Satellite System, from its architecture to its signal generation and processing strategy.
Methods and techniques that will be developed and used to carry out the research	The research will be developed in strict collaboration with the industry involved in the Space Assets Operations design and management. A period between 6 and 12 months, not necessarily continuous, will be spent in collaboration with that industrial partner, in form of an internship under the joint supervision of an academic and an industrial tutor, to create the opportunity of a fruitful bidirectional exchange between the worlds of research and industry. Particular attention will be given to run verification and validation of the implemented tools on real scenarios with existing data from the Company archives, if available. The doctoral student will follow doctoral courses at the Doctoral School of the Politecnico di Milano, selected to enhance their competencies in the fields related to the research topic.
Educational objectives	The objective of this Ph.D. is to develop skills and step forward the research in the field of GNSS systems and navigation techniques whenever applied to a multi-attractor environment such the Earth-Moon system is, affected by complex dynamics. During the research time framework, the candidate will develop skills in mathematical modelling, numerical analysis, filtering techniques, signal processing and fusion, computer programming (Matlab, Python, C/C++, and similar), and simulations. Soft skills in presenting the research, writing reports, outreach, dissemination, and preparing progress meetings will also be part of the gained skills. The Ph.D. student will also develop an open attitude towards innovation and exchange between the research and industrial worlds
Job opportunities	The job opportunities that this project opens up are in the field of complex space systems engineering, with a focus on onboard autonomy for navigation, distributed architectures as constellations design, spacecraft operations design and management, signal processing, development, and testing

Composition of the research group	1 Full Professors 0 Associated Professors 2 Assistant Professors 12 PhD Students
Name of the research directors	Prof. Michèle Lavagna

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 (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The Ph.D. candidate will receive a desk, a personal computer. Apart from the compulsory ones, the Ph.D. candidate will have the opportunity to follow additional courses, receive economic support to attend summer schools, and participate in conferences. There will be the possibility of paid teaching assistantship.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

THEMATIC Research Field: ADVANCED TECHNOLOGIES FOR PLANETARY IN SITU RESOURCE UTILISATION

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	A crucial capability to acquire to accomplish the foreseen plans in space manned exploration stays in systematically exploiting local resources to support future outposts, which would lead to significant independence from the terrestrial resources refurbishment which would be unbearable the longer the outposts are supposed to last. So planetary resources utilisation is a key capability towards future missions feasibility. Nowadays space engineering lacks the whole technology needed to implement and operate a planetary plant for in-situ resource management, from terrain sampling to manipulation and processing up to the aimed final product. The research focuses on identifying, characterizing and selecting promising processes for specific resource extraction from minerals existing in planetary terrain, with particular attention to Moon and Mars environment; the focus is on water, oxygen, and construction material production; synthesizing the viable design for a preferred resource extraction demonstrator plant to be flown; implementing a digital twin for the plant and the selected process supported by breadboards for critical technologies and processes efficiency verification and validation through lab experiments
Methods and techniques that will be developed and used to carry out the research	The research will be developed in strict collaboration with National Space Agency involved in flight opportunity preparation. A period between 6 and 12 months, not

	necessarily continuous, might be spent at the external premise to deepen specific topics related to the research, such as the planetary terrain characterization. The doctoral student will follow doctoral courses at the Doctoral School of the Politecnico di Milano, selected to enhance their competencies in the fields related to the research topic.
Educational objectives	The specific objective of this Ph.D. is to develop skills in space exploration system engineering with particular attention to the emerging field of the In Situ Resource Utilisation which is expected to be the first block of the lunar manned outpost. Being the research area intrinsically multidisciplinary, the candidate will gain competencies in multiphysics modelling, complex experiments design, implementation, setup and running, natural\artificial materials interaction management, and planetary science.
Job opportunities	The job opportunities that this project opens up are in the field of space system engineering, from the design to the implementation and operations management. Skills acquired will give access to jobs related to complex and technologically advanced plants engineering and management in the Earth industrial field as well.
Composition of the research group	1 Full Professors 0 Associated Professors 2 Assistant Professors 12 PhD Students
Name of the research directors	Prof. Michèle Lavagna

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 (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The Ph.D. candidate will receive a desk, a personal computer. Apart from the compulsory ones, the Ph.D. candidate will have the opportunity to follow additional courses, receive economic support to attend summer schools, and participate in conferences. There will be the possibility of paid teaching assistantship.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: AEROELASTICITY, VIBROACOUSTICS AND CONTROL OF STRUCTURES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The ability to model, simulate and control aeroservoelastic phenomena is a key factor for the successful design of many light structures. Reduction of transmitted vibrations and noise emission, either by means of active or passive solutions, is another extremely challenging engineering problems. Goal of the project is the development of new multidisciplinary modeling techniques and control methods. Possible fields of research include: development of advanced aeroservoelastic models, improvement of the control efficiency and effectiveness of multidisciplinary aeroservolelastic design and optimization techniques, the improvement of vibration transmission and noise emission modeling and control.
Methods and techniques that will be developed and used to carry out the research	Many methods and techniques may be developed and used. Among them: aerodynamic high fidelity models and reduced order simulation techniques; robust, scheduled-adaptive, linear-nonlinear control design; Statistical Energy Analysis, Wave-based approaches, advanced Finite Elements, improved analytical and semi-analytical structural models; development of damping materials constitutive laws and experimental identification of constitutive laws parameters; design and optimization of acoustic metamaterials; robust design of damping systems and vibrating machinery; hierarchical, multidisciplinary modeling of massively actuated fluid-elastic systems; design of centralized and decentralized

	distributed control systems.
Educational objectives	The student is expected to acquire multidisciplinary competences in some of the following research fields: aeroservoelastic modeling and control, optimization, structural design, vibration modeling and control, sound transmission and material modeling. He will likely use and improve modular, possibly parallel and multidisciplinary simulation and optimization codes.
Job opportunities	The multidisciplinary competences required for these projects are valuable assets for a quick and successful employment. The above research fields are crucial for a wide range of engineering applications, including aerospace, automotive, civil and marine ones.
Composition of the research group	1 Full Professors 2 Associated Professors 0 Assistant Professors 3 PhD Students
Name of the research directors	G. Ghiringhelli, M. Morandini

Contacts
paolo.mantegazza@polimi.it; 39 02 2399 8340 gianluca.ghiringhelli@polimi.it; 39 02 2399.8356 sergio.ricci@polimi.it; 39 02 2399.8319 giampiero.bindolino@polimi.it; 39 02 2399.8318 marco.morandini@polimi.it; +39 02 2399.8362 lorenzo.dozio@polimi.it; +39 02 2399.8329

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: AEROSPACE SYSTEMS AND CONTROL

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Aerospace engineering poses a formidable number of challenges in the systems and control area, both in view of the higher level of automation expected from flight vehicles and of the recent emergence of unmanned vehicles. Estimation and control systems design problems in aerospace are intrinsically challenging because of their multivariable, nonlinear nature, often associated with large model uncertainty and unstable dynamics. In view of this, the objective of the present research is to investigate, by means of a suitable combination of analytical and experimental methods, the main issues in the dynamics and control of full scale and small scale helicopters and multi-rotor aircraft, both manned and unmanned, ranging from single-vehicle attitude and position control to formation control and interaction with the environment (e.g., vehicle-to-vehicle and vehicle-to-infrastructure interaction, aerial manipulation).
Methods and techniques that will be developed and used to carry out the research	Combinations of first principle and experimental modelling; state estimation methods; robust, adaptive, nonlinear control; analysis and design in simulation; experimental work on small-scale vehicles in a dedicated laboratory.
Educational objectives	Understanding of the state of the art in systems and control methods; expertise in developing computational tools, and performing experiments; verification of developed methods via numerical simulation and

	experiments.
Job opportunities	Senior flight dynamicist; senior flight control engineer.
Composition of the research group	1 Full Professors 0 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	Marco Lovera

Contacts
Marco Lovera: marco.lovera@polimi.it, (Tel.) +39-02-2399.3592, https://home.aero.polimi.it/lovera

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: AIRCRAFT CRASHWORTHINESS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Crashworthiness has become an issue for all aircraft categories. The introduction and more extensive use of composite parts in the aiframe needs a deep study of the structural response to dynamic loading, which ranges from the extended damage of an emergency landing conditions to local damage of a bird impact, and includes fuel system integrity and biomechanic of impacts. From the numerical point of view, the refinement of materials constitutive laws is of utmost importance, as well as more efficient techniques to model the occupants response and assess the injury risk.
Methods and techniques that will be developed and used to carry out the research	Dynamic and crash tests on material specimens and structural components; finite element and lumped mass techniques for numerical modelling and analysis; refinement of fluid-structure interaction laws.
Educational objectives	Deep learning of the experimental and numerical techniques to investigate structural crashworthiness.
Job opportunities	Senior structure engineer
Composition of the research group	1 Full Professors 3 Associated Professors 2 Assistant Professors 1 PhD Students
Name of the research directors	M. Anghileri, P. Astori, G. Janszen

Contacts
marco.anghileri@polimi.it, (Tel.) +39-02-2399.7162 paolo.astori@polimi.it, (Tel.) +39-02-2399.8337 gerardus.janszen@polimi.it, (Tel.) +39-02-2399.8366

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

INTERDISCIPLINARY Research Field: MODEL-BASED DIGITAL TWINS FOR SPACE CYBERSECURITY

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,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.
Methods and techniques that will be developed and used to carry out the research	The proposed project has the ambition to 1) embrace digital twin concepts inspired by engineered resilient systems and 2) accelerate the adoption of model-based systems engineering (MBSE) within the space engineering community. The idea is to leverage new digital techniques to allow cyber security assessments, like those performed within cyber ranges, to deploy novel cyber threat intelligence and cyber threat analyses. The multidisciplinary MBSE approach proposed relies on the abstraction of the inherently multi-physics systems typical of the space domain, and is organized in four layers: 1) Modeling of the multidisciplinary systems from first principles, 2) Implementation of the mathematical/physical models into resilient and efficient numerical frameworks, so allowing system simulations at the fringe of their design space, 3) definition of real-life interfaces between the digital twins of the space/ground segments and a cyber range, and 4) developments of methods and tools for cyber threat intelligence and cyber threat analysis purposely developed for ground-based and

	space-segment assets. The proposed PhD project combines renowned expertise in the field of space systems modeling and simulation, and of cybersecurity threat modeling (with a specific emphasis on the peculiarity of cyber-physical systems). These two branches are both at the edge of research in their fields, and they are merged here to forge a novel research line. Within Polimi, there is a unique chance to pave the way for a massive collaboration between the two proposing research groups and to intercept the needs of the two communities. The added value of the project is in the synergy that can be deployed by the two research groups working together, with the PhD student acting as a pivot between them.
Educational objectives	The objective of this PhD is to develop skills in space system modelling and simulation as well as in space system cyber security. The candidate will gain relevant expertise in near-Earth and deep-space missions. Through this project, the candidates will develop skills in mathematical modeling, numerical analysis, computer programming (Matlab, Python, C++, or similar), and cyber security. Moreover, the candidate will develop skills in both computer and processor/hardware-in-the-loop simulations. Soft skills in disseminating the research, writing reports, performing outreach, and preparing industrial progress meetings will be also achieved through the PhD project.
Job opportunities	The current research prepares the PhD candidate for both academic and industrial careers. Knowledge of model-based system engineering, modeling, and simulation of space systems, as well as space system cyber security are fundamental skills for space careers in companies and universities.
Composition of the research group	1 Full Professors 0 Associated Professors 1 Assistant Professors 11 PhD Students
Name of the research directors	Prof. Francesco Topputo

Contacts
Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano Via La Masa 34, 20156, Milano - Italy Phone: +390223998351/7157 email: francesco.topputo@polimi.it web site: www.aero.polimi.it or https://dart.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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The candidate will be hosted in the DART Lab (Deep-space Astrodynamics Research & Technology Laboratory) at the Department of Aerospace Science and Technology, Politecnico di Milano. During the PhD program, the candidate will have access to the facilities of the DART Lab to carry out experimental activities. The candidate will also have the opportunity to attend some PhD classes on both soft and hard skills. Moreover, there could be the possibility to carry out activities as a teaching assistant. The PhD candidate will receive a desk, a personal computer. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses, receive economic support to attend summer schools, and participate in conferences. There will be the possibility of paid teaching assistantship.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: OPTIMAL DESIGN OF MORPHING WINGS BASED ON COMPLIANT STRUCTURES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The great interest in developing morphing wings is mainly based on their capability to adapt their shape to optimize some specific aircraft performance indices during the mission. Nevertheless, the design and of these kind of adaptive structures requires the availability of adhoc developed procedures able to tackle the conflicting requirements such as the high deformability requested to change the airfoil shape coupled to the load carrying capability. One of the most promising concept recently proposed for morphing wings is one based on the concept of distributed compliant structures.
Methods and techniques that will be developed and used to carry out the research	To fully exploit all the potential benefits of the adaptive and morphing concepts, it is requested to adopt the typical techniques of the Multi-Disciplinary Optimization (MDO). The PhD candidate will contribute to the development of such as procedures as well to the design and testing of experimental demonstrators to validate the morphing concepts. The research will be developed in the framework of a new EU funded research project.
Educational objectives	This research topic will provide training of PhD candidates in fundamental disciplines, like structural design, and aeroelasticity, as well as in MDO techniques, in an international environment.
Job opportunities	Researchers with a strong background in fundamental

	disciplines as well as in multidisciplinary methodologies are strongly requested by industries, non limited to the aerospace field.
Composition of the research group	1 Full Professors 0 Associated Professors 0 Assistant Professors 2 PhD Students
Name of the research directors	Sergio Ricci

Contacts
Email: sergio.ricci@polimi.it, (Tel.) +39-02-2399.8319 Web: www.aero.polimi.it/ricci Project homepage: www.aero.polimi.it/ricci/morphing.php

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: PHYSICAL FLUID DYNAMICS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Research activities at the Physical Fluid Dynamics Laboratory (PFDL) are aimed at understanding fundamental issues arising in fluid flows operating at highly non-ideal conditions, including flows of rarefied gases, multi-phase and interfacial flows and the fluid dynamics of vapors close to the liquid-vapor saturation curve and critical point, using a comprehensive theoretical, experimental and numerical approach. The expertise in these research areas is a necessary requirement to tackle applications such as e.g. the aero-thermodynamics of re-entry vehicles, vacuum systems design, sustainable energy and flow processes in micro- and nano-devices.
Methods and techniques that will be developed and used to carry out the research	CFD techniques for non-ideal and multiphase fluids (Volume of Fluid, Diffuse Interface Models); Monte Carlo and Molecular Dynamics
Educational objectives	Matching macroscopic and microscopic approaches to achieve a deeper understanding of fluid behavior and improve modeling tools.
Job opportunities	Senior fluid dynamicist for energy, space and material science applications.
Composition of the research group	2 Full Professors 1 Associated Professors 1 Assistant Professors 5 PhD Students

POLITECNICO DI MILANO

Name of the research directors	M. Belan, A. Frezzotti, A. Guardone

Contacts
marco.belan@polimi.it , +39-02-2399.8045 aldo.frezzotti@polimi.it, +39-02-2399.8385 luigi.quartapelle@polimi.it, +39-02-2399.8358 luigi.vigevano@polimi.it, (Tel.) +39-02-2399.8317 alberto.guardone@polimi.it, (Tel.) +39-02-2399.8393

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: ROTORCRAFT AERODYNAMICS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Rotorcraft aerodynamics is a very challenging subject, due to the coexistence of several physical features: unsteadiness, shocked flow, flow separation, complex vertical wakes, noise, fluid/structure interaction. The objective of the present research is to investigate, by means of apposite experiments and newly developed experimental techniques, and existing high-fidelity CFD/CSD simulation tools for fluid/structure coupling, the challenging fundamental and applied aerodynamic features of helicopters and tilt-rotor aircrafts, like tilt-rotor interference effects, blade dynamic stall, blade- vortex interaction, helicopter-obstacle interference effects, rotorcraft drag reduction.
Methods and techniques that will be developed and used to carry out the research	Wind tunnel tests, development of experimental techniques, coupling of CFD and multi-body in-house codes for fluid-structure interaction, development of new generation unstructured, adaptive CFD codes for accurate simulation of blade-vortex interaction and vorticity dynamics.
Educational objectives	Deep understanding of the flow physics of rotary wing vehicles, expertise in developing computational tools, and performing experiments, assessment of numerical simulation and experiments results.
Job opportunities	Senior aerodynamicist

Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	L. Vigevano, G. Gibertini, A. Guardone

Contacts
luigi.vigevano@polimi.it, (Tel.) +39-02-2399.8317 giuseppe.gibertini@polimi.it, (Tel.) +39-02-2399.8389 alberto.guardone@polimi.it, (Tel.) +39-02-2399.8393

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: ROTORCRAFT AEROMECHANICS AND DESIGN

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Rotorcraft aeromechanics encompasses flight dynamics and control, rotor dynamics and aeroelasticity. These disciplines are crucial to modern rotorcraft design and analysis, given the intimate coupling of aerodynamics, structural dynamics, control and aeroelasticity impacting on rotorcraft performance and handling qualities. The objective of the present research is to integrate and augment existing prediction methods of varying levels of fidelity to support the analysis and optimal design of rotorcraft system, including nonconventional configurations. The derivation of design criteria is sought, with special attention to innovative light rotorcraft and new generation tilt-rotors.
Methods and techniques that will be developed and used to carry out the research	Integration of flexible multibody solvers, performance (flight mechanics) prediction tools, blade/rotor structural analysis tools, and other simulation codes within an optimization environment for rotorcraft design. These technology will be used to design, optimize and verify one or more rotorcraft systems.
Educational objectives	Expertise in modern integrated aircraft design methodologies and tools, deep understanding of rotorcraft aeromechanics.
Job opportunities	Senior aircraft designer/flight dynamicist/rotor dynamicist
Composition of the research group	0 Full Professors 2 Associated Professors

	1 Assistant Professors 1 PhD Students
Name of the research directors	Lorenzo Trainelli, Alessandro Croce

Contacts
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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

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

There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: ROTORCRAFT MULTIDISCIPLINARY DESIGN

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Modeling the dynamics of helicopters requires the tight integration of several disciplines. Nonlinear structural dynamics, steady and unsteady aerodynamics, control systems and other subsystems modeling, like hydraulics, ice formation and shedding or even biomechanics are required to investigate such complex dynamical system. The objective of this research is to develop multidisciplinary virtual simulation systems to be used for the enhancement of rotorcraft. These include numerical models and flight simulators, which are used to investigate problems related to human machine interaction. Within this research field several problems have been, and need to be, tackled, including: aeroservoelastic stability, rotorcraft pilot coupling, vibration control, ice accretion, morphing systems development, Gurney flaps design and analysis.
Methods and techniques that will be developed and used to carry out the research	The development of numerical virtual models will be based on the exploitation of multibody-multidisciplinary codes developed in-house, along with several open and in -house CFD solvers. Fixed-base flight simulators, which belong to the FRAME Lab, will be developed and used to investigate the interaction of the systems with pilots and operators.
Educational objectives	Deep understanding of the dynamics of rotary wing vehicles, expertise in developing computational tools, and performing experiments, assessment of numerical

	simulation and experiment results.
Job opportunities	Senior flight physics expert or senior dynamicist.
Composition of the research group	3 Full Professors 0 Associated Professors 1 Assistant Professors 6 PhD Students
Name of the research directors	G. Quaranta, P. Masarati, A. Guardone

Contacts
giuseppe.quaranta@polimi.it, (Tel.) +39-02-2399.8405 pierangelo.masarati@polimi.it, (Tel.) +39-02-2399.8309 alberto.guardone@polimi.it, (Tel.) +39-02-2399.8393

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: SPACE MISSIONS ENGINEERING

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The research in this field covers a variety of research topics. For the major part, research activities fall into the broad area of mission analysis, space trajectories design, space systems and space robotics, which are not only of academic interest but also with a strong relationship with industrial applications. Subtopics such as spacecraft design, mission planning, on-board autonomy, trajectory optimization, navigation, control and planetary exploration are covered.
Methods and techniques that will be developed and used to carry out the research	As appropriate to each specific research project, methods and techniques adopted include development and application of analytical and numerical tools as well as experimental methodologies.
Educational objectives	To create specialists in the field of mission analysis and space systems optimization by means of advanced courses, to improve and broaden technical knowledge and skills of PhD candidates, and direct participation to world-class research activities.
Job opportunities	Foreseen job activities include: (1) research in international and Italian space agencies; (2) industries related to the design and manufacturing of satellites and space components; (3) research in Italian and foreign universities. Post-doctoral grants are available to Ph.D. within the department.

Composition of the research group	1 Full Professors 1 Associated Professors 3 Assistant Professors 7 PhD Students
Name of the research directors	F. Bernelli, M. Lavagna, M. Massari, F. Topputo

Contacts
Franco.Bernelli@polimi.it, (Tel.) +39-02-2399.8328 Pierluigi.Dilizia@polimi.it, (Tel.) +39-02-2399.8370 Michelle.Lavagna@polimi.it, (Tel.) +39-02-2399.8364 Mauro.Massari@polimi.it, (Tel.) +39-02-2399.8379 Francesco.Topputo@polimi.it, (Tel.) +39-02-2399.8351 Homepage: http://www.aero.polimi.it/~space

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: SPACE PROPULSION

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Access to space and in-space propulsion are important and challenging areas of research for the future of the mankind. Chemical is a multidisciplinary subject where chemistry, thermodynamics, mechanics, and fluid dynamics concur to build up rocket system performance. Current research roadmaps are inspired by cost reduction, green propulsion, and application to novel missions (such as satellite deorbiting). These subjects are present in the FLPP (Future Launcher Preparatory Program) and CleanSky initiatives. The subject that will be developed in the program will follow such framework, with specific emphasis on novel rocket configurations, fuels and propellants, performance prediction, and combustion-related aspects.
Methods and techniques that will be developed and used to carry out the research	The candidate will develop experimental rigs for material fire testing, 0-D or 1-D numerical models for rocket performance prediction, advanced techniques for combustion diagnostics (high speed video techniques, microthermocouples, microcalorimetry etc.). Thermo-mechanical characterizations (TGA/DT, DSC, DMA, rheometer) will be applied for formulation development.
Educational objectives	Understanding of rocket performance affecting factors and capability to develop, implement, and use advanced methodologies for their prediction, characterization, and improvement. Use of standard and dedicated diagnostic techniques. Development of capability for test campaign

	planning, result analysis and interpretation.
Job opportunities	Senior propulsion engineer or research scientist in companies or institutions involved in space propulsion.
Composition of the research group	1 Full Professors 0 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Luciano Galfetti, Filippo Maggi

Contacts
luciano.galfetti@polimi.it, (Tel.) +39-02-2399.8526 filippo.maggi@polimi.it, (Tel.) +39-02-2399.8287

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: STRUCTURAL INTEGRITY OF ADVANCED MATERIALS AND STRUCTURES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The application of innovative materials and structural concepts in modern vehicle structures introduces new challenging tasks in the design methodologies. Composites materials with polymeric or ceramic matrices, as well as hybrid and smart structures are difficult to be designed and verified by using classical stress-based analysis. In such cases, the analysis of the structural integrity requires more complete and multi-scale numerical approaches, based on non-linear constitutive laws, which can take into account defects, residual stresses induced by manufacturing process, development of subcritical damages and statistical distribution of properties. The objective of the research is a further development of existing approaches and constitutive laws, at different scale levels, and their effective application in the design process of real-world advanced composite and smart structures.
Methods and techniques that will be developed and used to carry out the research	The research will involve a possible development of new constitutive laws for the thermo-mechanical response of materials, and the application of already developed modeling techniques for the design of structural components, within a multi-scale approach and a strong interaction with experimental activities.
Educational objectives	Acquisition of numerical and testing skill for the management of the design process of advanced structural

	components
Job opportunities	Senior design engineer of composite/smart structures, Senior materials scientist
Composition of the research group	1 Full Professors 1 Associated Professors 2 Assistant Professors 1 PhD Students
Name of the research directors	A. Airoldi, G. Sala, L. Di Landro, P. Bettini

Contacts
alessandro.airoldi@polimi.it (tel. +39-02-2399.8363) giuseppe.sala@polimi.it (tel. +39-02-2399.8361) luca.dilandro@polimi.it (tel. +39-02-2399.8398) paolo.bettini@polimi.it (tel. +39-02-2399.8391)

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.

POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

OPEN SUBJECT Research Field: TURBULENT FLOWS, INSTABILITY AND CONTROL

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	This is a wide research field with instability and turbulence as its main themes. Turbulent flows are all-encompassing in applications, and their numerical simulation (at various cost and accuracy levels, ranging from RANS to DNS) is essential in the design process of virtually any system where fluid is in motion. Flow control is a young research field where one tries to improve the performance of a fluid system by external manipulation (e.g. actuators) or simply by improved design (shape optimization). In either case, properly choosing the optimization strategy is a key element for a successful flow control. Sometimes flow control acts on a developing flow to hinder its instabilities; other times the control strategy aims at modifying the cyclic behaviour of a dynamical system.
Methods and techniques that will be developed and used to carry out the research	From the numerical standpoint, this research field typically employs a number of techniques spanning from DNS to LES and RANS, and a broad range of powerful mathematical tools. The group is active in developing and improving numerical tools in DNS (e.g. highly efficient parallel solver) and LES (e.g. developing a new hybrid RANS/LES model; studying the grid and p-adaptivity for a Discontinuous Galerkin Finite element). From the experimental viewpoint, the group has in the recent past specialized in experimental measurement of turbulent skin -friction drag reduction, and has succeeded to measure the (so far) largest ever reduction of pressure loss in a pipe via active flow control. Moreover, we develop plasma (DBD and corona) actuators that attract considerable

	interest from industries. From the standpoint of control laws, that need be derived from a profound physical insight, we are leading the research of energy-efficient control laws for turbulent skin-friction drag reduction in wall-bounded flows. We employ several optimization strategies, including those based on the adjoint operator.
Educational objectives	Deep understanding of the physics of a near-wall turbulent flow is a common educational goal. Depending on the specific project, additional objectives may be control theory, or experience in laboratory work, actuator development, high-level computer programming, high-performance computing.
Job opportunities	CFD engineer, control specialist, experimental aerodynamicist
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 5 PhD Students
Name of the research directors	A. Abbà, F. Auteri, M. Belan, M. Quadrio

Contacts
antonella.abba@polimi.it, (Tel.) +39-02-2399.8354 franco.auteri@polimi.it, (Tel.) +39-02-2399.8046 marco.belan@polimi.it, (Tel.) +39-02-2399.8045 maurizio.quadrio@polimi.it, (Tel.) +39-02-2399.8349

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
There is the possibility to get 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. Individual desk and individual personal computer will be provided. PhD students have access to fixed amount of funding to participate to summer schools and conferences and to buy research/educational materials.