



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.



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 Research, 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.



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.



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 Research, 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



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. Airoidi, P. Bettini

Contacts
giuseppe.sala@polimi.it (tel. +39-02-2399.8361) luca.dilandro@polimi.it (tel. +39-02-2399.8398) alessandro.airoidi@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
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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 Research, 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 aeroservoelastic 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	
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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
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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 Research, 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
<p>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.</p> <p>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.</p>



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 Research, 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 airframe 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

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Additional support - Financial aid per PhD student per year (gross amount)	
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Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

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

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

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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 Research, 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
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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 Research, 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



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



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 Research, 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
<p>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.</p>



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 Research, 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

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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.



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 Research, 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

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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
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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 Research, 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

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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.



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 Research, 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. Airoidi, G. Sala, L. Di Landro, P. Bettini

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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.



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 Research, 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

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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.