POLITECNICO DI MILANO

# PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 39th cycle

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| **Number of scholarship offered** | 5 |
| **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, and service companies. The Ph.D. program gives particular emphasis to the development of multi-disciplinary thinking and problem-solving skills in students, with particular 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 course level 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 and technical areas not strictly related to the aerospace field. Examples of Ph.D. thesis topics are 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 - 39th cycle

## OPEN SUBJECT Research Field: ADVANCED MATERIALS AND TECHNOLOGIES

| Monthly net income of PhDscholarship (max 36 months) |
|---|
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **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 and sustainability will depend on the capability of self-monitoring, self-healing, and to the possibility of recycling/reuse, respectively. Their affordability will depend on the capability of incorporating HUMS (health and usage monitoring systems) for implementing predictive maintenance approaches.<br>Besides, advanced manufacturing technologies, including additive ones, will enable the integration, reliably and profitably, of all these characteristics into aerospace structures.<br>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 multiscale numerical approaches, actuating/sensing/healing strategies, and advanced production technologies (additive, out-of-autoclave). |
| **Educational objectives** | To develop the capability to design smart structures and assess related process techniques. To gain experience in |

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| | managing multi-tools research approaches. |
| **Job opportunities** | Researcher with a broad background in fundamental disciplines including materials and manufacturing engineering, production process manager, and senior test engineer. |
| **Composition of the research group** | 2 Full Professors<br>1 Associated Professors<br>1 Assistant Professors<br>9 PhD Students |
| **Name of the research directors** | G. Sala, L. Di Landro, P. Bettini, A. M. Grande |

| **Contacts** |
|---|
| Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano Via La Masa 34, 20156, Milano - Italy<br><br>giuseppe.sala@polimi.it (tel. +39 02 2399 8361)<br>luca.dilandro@polimi.it (tel. +39 02 2399 8398)<br>paolo.bettini@polimi.it (tel. +39 02 2399 8391)<br>antoniomattia.grande@polimi.it (tel. +39 02 2399 8369) |

| **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 be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: ADVANCES IN SPACE MISSION DESIGN AND SPACE SYSTEMS

| Monthly net income of PhDscholarship (max 36 months) |
|---|
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **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 trajectory 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, planetary science and exploration, space situational awareness, and space traffic management 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 the 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 the technical knowledge and skills of Ph.D. candidates, and direct participation in world-class research activities. |
| **Job opportunities** | Foreseen job activities include (1) research in international, European, and Italian space agencies; (2) industries related to the design and manufacturing of satellites and space components, space operations, and provision of services from space; (3) research in Italian |

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| | and foreign universities. Post-doctoral grants are available to Ph.D. within the department. |
| **Composition of the research group** | 3 Full Professors<br>3 Associated Professors<br>6 Assistant Professors<br>25 PhD Students |
| **Name of the research directors** | F. Bernelli, M. Lavagna, F. Topputo |

| **Contacts** |
|---|
| Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano Via La Masa 34, 20156, Milano - Italy<br>Franco.Bernelli@polimi.it, (Tel.) +39-02-2399.8328<br>Michelle.Lavagna@polimi.it, (Tel.) +39-02-2399.8364<br>Francesco.Topputo@polimi.it, (Tel.) +39-02-2399.8351<br>Camilla.Colombo@polimi.it, (Tel.) +39-02-2399.8352<br>Pierluigi.Dilizia@polimi.it, (Tel.) +39-02-2399.8370<br>Mauro.Massari@polimi.it, (Tel.) +39-02-2399.8379<br>Fabio1.Ferrari@polimi.it, (Tel.) +39-02-2399.8320<br>Gabriella.Gaias@polimi.it, (Tel.) +39-02-2399.8325<br><br>https://www.aero.polimi.it/en/research-labs/sme--14 |

| **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 be provided with office space and a personal computer if needed. 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. The Ph.D. candidate will be involved in the research and commercial projects of the research group. There will be the possibility of paid teaching assistantship. |

POLITECNICO DI MILANO

# PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 39th cycle

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

| Monthly net income of PhDscholarship (max 36 months) |
| --- |
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **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. |

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| | 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<br>2 Associated Professors<br>0 Assistant Professors<br>3 PhD Students |
| **Name of the research directors** | G. Ghiringhelli, M. Morandini |

| **Contacts** |
|---|
| gianluca.ghiringhelli@polimi.it; 39 02 2399.8356<br>marco.morandini@polimi.it; +39 02 2399.8362<br>lorenzo.dozio@polimi.it; +30 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** |
|---|
| The Ph.D. candidate will be provided with office space and a personal computer if needed. 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. |


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# PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 39th cycle

## OPEN SUBJECT Research Field: AEROSPACE SYSTEMS AND CONTROL

| Monthly net income of PhDscholarship (max 36 months) |
|---|
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **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.<br>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 |

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| | experiments. |
| **Job opportunities** | Senior flight dynamicist; senior flight control engineer. |
| **Composition of the research group** | 1 Full Professors<br>0 Associated Professors<br>1 Assistant Professors<br>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** |
|---|
| The Ph.D. candidate will be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: AIRCRAFT CRASHWORTHINESS

| Monthly net income of PhDscholarship (max 36 months) |
|---|
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **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<br>3 Associated Professors<br>2 Assistant Professors<br>1 PhD Students |
| **Name of the research directors** | M. Anghileri, P. Astori, G. Janszen |

| Contacts |
|---|
| marco.anghileri@polimi.it, (Tel.) +39-02-2399.7162<br>paolo.astori@polimi.it, (Tel.) +39-02-2399.8337<br>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 |
|---|
| The Ph.D. candidate will be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: MULTIDISCIPLINARY DESIGN OPTIMIZATION OF PASSIVE, ACTIVE AND MORPHING AEROSPACE STRUCTURES

| Monthly net income of PhDscholarship (max 36 months) |
| --- |
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **Motivation and objectives of the research in this field** | Optimal design of innovative aerospace structures aims to provide these kinds of structures the ability to adapt to mission requirements or external changes achieving near-optimal performances in multiple operating conditions. This approach needs specific design procedures combined with different technologies that can be combined with each other: passive structures that respond to external events without the need for active control systems; actively controlled structures that enable to extend the operational envelope or reduce the effects of external changes via a dynamic adaptation and the use of sensors and actuators; morphing structures which is a family of innovative structures related to the capability of continuously changing their external shape across the operational envelope, via a time-varying adaptation. |
| **Methods and techniques that will be developed and used to carry out the research** | To fully exploit all the potential benefits of innovative structures, it is requested to adopt Multidisciplinary Design Optimization (MDO) procedures, appropriately developed to consider advanced manufacturing technologies and multifunctional materials. The Ph.D. candidate will contribute to the development of such procedures as well as to the design and testing of experimental/wind tunnel demonstrators aiming at the validation of new concepts. |
| **Educational objectives** | Know-how in design optimization, structural dynamics, aerospace materials, and manufacturing. Expertise in |

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| | developing MDO techniques and performing experimental/wind tunnel tests. |
| **Job opportunities** | Senior researcher with a strong background in fundamental disciplines, interaction across multiple disciplines, design methodologies, experimental/wind tunnel testing, and use of control and automation techniques. The above scientific skills cover a wide range of engineering applications and are strongly requested by industries, non-limited to the aerospace field. |
| **Composition of the research group** | 1 Full Professors<br>0 Associated Professors<br>2 Assistant Professors<br>2 PhD Students |
| **Name of the research directors** | S. Ricci, A. De Gaspari, A. M. Grande |

| **Contacts** |
|---|
| Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano Via La Masa 34, 20156, Milano – Italy<br>sergio.ricci@polimi.it (PH. +39 02 2399 8319)<br>alessandro.degaspari@polimi.it (Ph. +39 02 2399 8368)<br>antoniomattia.grande@polimi.it (Ph. +39 02 2399 8369) |

| **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 be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: PHYSICAL FLUID DYNAMICS

| Monthly net income of PhDscholarship (max 36 months) |
| --- |
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **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<br>1 Associated Professors<br>1 Assistant Professors<br>5 PhD Students |

| Name of the research directors | M. Belan, A. Guardone |
|---|---|

| Contacts |
|---|
| marco.belan@polimi.it , +39-02-2399.8045<br>alberto.guardone@polimi.it, (Tel.) +39-02-2399.8393<br>luigi.vigevano@polimi.it, (Tel.) +39-02-2399.8317 |

| 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 be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: ROTORCRAFT AERODYNAMICS

| Monthly net income of PhDscholarship (max 36 months) |
| --- |
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
| --- | --- |
| **Motivation and objectives of the research in this field** | Rotorcraft aerodynamics is a very challenging subject, due to the coexistence of several physical features: unsteadiness, shocked flow, flow separation, complex vertical wakes, noise, and 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, eVTOLs, and tilt-rotor aircraft, like rotor-rotor and rotor-wing 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 mid-fidelity CFD simulations to 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 |

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| **Composition of the research group** | 1 Full Professors<br>3 Associated Professors<br>0 Assistant Professors<br>9 PhD Students |
| **Name of the research directors** | L. Vigevano, G. Gibertini, A. Guardone, A. Zanotti |

| **Contacts** |
|---|
| luigi.vigevano@polimi.it, (Tel.) +39-02-2399.8317<br>giuseppe.gibertini@polimi.it, (Tel.) +39-02-2399.8389<br>alberto.guardone@polimi.it, (Tel.) +39-02-2399.8393<br>alex.zanotti@polimi.it, (Tel.) +39-02-2399.8066 |

| **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 be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: ROTORCRAFT AEROMECHANICS AND DESIGN

| Monthly net income of PhDscholarship (max 36 months) |
|---|
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
|---|---|
| **Motivation and objectives of the research in this field** | 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<br>2 Associated Professors |

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|---|---|
| | 1 Assistant Professors<br>1 PhD Students |
| **Name of the research directors** | Lorenzo Trainelli, Alessandro Croce |

| **Contacts** |
|---|
| Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano Via La Masa 34, 20156, Milano - Italy +390223998323 - email: phd-daer@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 be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: ROTORCRAFT MULTIDISCIPLINARY DESIGN

| Monthly net income of PhDscholarship (max 36 months) |
| --- |
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
| --- | --- |
| **Motivation and objectives of the research in this field** | Modeling the dynamics of rotorcraft 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, and pilots and passenger biomechanics are required to investigate such complex dynamical systems. The objective of this research is to develop multidisciplinary virtual simulation systems to be used for the enhancement of the conception, design, analysis, testing, certification, and operation of rotorcraft and eVTOL, also in view of advanced air mobility and the revolution it promises to bring into this research area. Numerical models and flight simulators 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, and morphing systems. |
| **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, motion-base platforms for pilot biomechanical testing, and various virtual reality-based platforms that belong to the FRAME Lab will be developed and used to investigate the interaction of the systems with pilots and operators. |
| **Educational objectives** | |

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| | 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<br>0 Associated Professors<br>1 Assistant Professors<br>10 PhD Students |
| **Name of the research directors** | G. Quaranta, P. Masarati, A. Guardone |

| **Contacts** |
|---|
| giuseppe.quaranta@polimi.it, (Tel.) +39-02-2399.8405<br>pierangelo.masarati@polimi.it, (Tel.) +39-02-2399.8309<br>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** |
|---|
| The Ph.D. candidate will be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: SPACE PROPULSION

| Monthly net income of PhDscholarship (max 36 months) |
| --- |
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
| --- | --- |
| **Motivation and objectives of the research in this field** | 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 |

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| | 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<br>0 Associated Professors<br>1 Assistant Professors<br>3 PhD Students |
| **Name of the research directors** | Filippo Maggi |

| **Contacts** |
|---|
| 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** |
|---|
| The Ph.D. candidate will be provided with office space and a personal computer if needed. 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 - 39th cycle

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

| Monthly net income of PhDscholarship (max 36 months) |
| --- |
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **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 |

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| | components |
| **Job opportunities** | Senior design engineer of composite/smart structures,<br>Senior materials scientist |
| **Composition of the research group** | 1 Full Professors<br>1 Associated Professors<br>2 Assistant Professors<br>1 PhD Students |
| **Name of the research directors** | A. Airoldi |

| **Contacts** |
|---|
| alessandro.airoldi@polimi.it (tel. +39-02-2399.8363) |

| **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 be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: TURBULENT FLOWS, INSTABILITY AND CONTROL

| Monthly net income of PhDscholarship (max 36 months) |
|---|
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **Motivation and objectives of the research in this field** | This is a wide research field encompassing instability and turbulence. Turbulent flows are widespread in applications; their numerical simulation (at various cost and accuracy levels, ranging from RANS to DNS) is essential in the design process of virtually any system with a moving fluid. The statistical description of turbulent flows is a field of fundamental research. In flow control, one aims at improving the performance of a fluid system by external manipulation (e.g. actuators) or simply by improved design (shape optimization or surface texturing). 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** | When studying instability and turbulence, a number of numerical techniques are employed, ranging from DNS to LES and RANS, together with 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. new hybrid RANS/LES models; studying the grid and p-adaptivity for a Discontinuous Galerkin Finite element). From the experimental viewpoint, we develop plasma actuators for a number of applications. From the standpoint of control laws, we are leading the research of energy-efficient control laws for turbulent skin-friction drag reduction in wall-bounded flows. Several optimization strategies, including those based on the adjoint operator, are used in |

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| | a number of applied problems, including some of biomedical interest. |
| **Educational objectives** | Understanding 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, and high-performance computing. |
| **Job opportunities** | CFD engineer, control specialist, experimental aerodynamicist |
| **Composition of the research group** | 1 Full Professors<br>2 Associated Professors<br>1 Assistant Professors<br>2 PhD Students |
| **Name of the research directors** | Prof. A. Abbà, F. Auteri, M. Belan, M. Quadrio |

| **Contacts** |
|---|
| Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano Via La Masa 34, 20156, Milano - Italy +39022399<br>antonella.abba@polimi.it, (Tel.) +39-02-2399.8354<br>franco.auteri@polimi.it, (Tel.) +39-02-2399.8046<br>marco.belan@polimi.it, (Tel.) +39-02-2399.8045<br>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** |
|---|
| The Ph.D. candidate will be provided with office space and a personal computer if needed. 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 - 39th cycle

## OPEN SUBJECT Research Field: WIND ENERGY SYSTEMS

| Monthly net income of PhDscholarship (max 36 months) |
| --- |
| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **Motivation and objectives of the research in this field** | Systems for generating electricity from renewable sources, and in particular from wind, are continuously expanding to meet the ever-increasing demand for green electrification.<br>Conventional on-shore and off-shore wind turbines have reached dimensions and complexity that, together, create ongoing challenges. But even small wind turbines, with a horizontal or vertical axis, have different complexities due to their particular applications and lower costs. Finally, new technologies, such as high-altitude power generation, Airborne Wind Energy Systems, are joining the previous ones to complete the energy mix and pose new technological challenges.<br>These complex systems have their own characteristics but also others in common, including the need to integrate several advanced engineering technologies (aerodynamics, structure, material, aeroelasticity. control, etc.) into a single effective multidisciplinary complex system.<br>For this reason, the goal of this research is to develop technologies for the multidisciplinary design, analysis, and optimization (MDAO) of such complex systems. |
| **Methods and techniques that will be developed and used to carry out the research** | The research is carried out through a mix of numerical and experimental activities. The development of tools for MDAO may be done in synergy with any project-funded experimental tests that are quite regularly found within the research group. |

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| | The numerical tools are mainly developed within the research group (such as aero-servo-hydro-elastic code, wind turbine design tool, engineering models, etc.) or open-source tools may be used and updated. |
| **Educational objectives** | The main educational objective is to develop skills for the analysis and system integration of technologically advanced complex systems, such as floating offshore wind turbines, small land-based wind turbines, and airborne wind energy systems.<br>Moreover, one learns to identify the appropriate mathematical model for the type of task and to integrate this model into a much more complex multidisciplinary system.<br>Finally, one learns to work in a team, getting involved in activities with other researchers in the group. |
| **Job opportunities** | This research activity opens up the industrial world where highly complex systems integration skills are required. Therefore not only in the wind energy sector (wind turbine manufacturers and/or wind farm operators) but also in related industries, such as aerospace, automotive, racing boats, etc. |
| **Composition of the research group** | 0 Full Professors<br>1 Associated Professors<br>2 Assistant Professors<br>4 PhD Students |
| **Name of the research directors** | Prof. Alessandro Croce |

| **Contacts** |
|---|
| Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano, Via La Masa 34, 20156, Milano, Italy<br>Phone +390223998322<br>email: alessandro.croce@polimi.it<br>web site: www.aero.polimi.it, www.poliwind.polimi.it |

| **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** | |
|---|---|
| **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 be provided with office space and a personal computer if needed. 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.