POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

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

Description of the PhD Programme

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

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PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

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

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

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

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

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

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

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

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

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

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PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

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

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

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

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

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