Allegato 1B

PhD in Aerospace Engineering

Description of the PhD Programme

The PhD program 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 level of the course allows the graduates to compete in a European and international environment. Over the years the PhD students have developed researches relevant to aircraft, rotorcraft and space applications, but also to technical areas not strictly related to the aerospace field. Example of PhD thesis topics are in:

- Computational and experimental fluid mechanics.
- Aeroservoelasticity, dynamic and control of aerospace structures.
- Flight mechanics and flight control.
- Passive structural safety of both aerospace and non-aerospace vehicles.
- Space missions analysis and design.
- Orbital mechanics and control
- Space debris
- Planetary protection
- Space situation awareness
- Innovative materials and structures design and testing.
- Advanced rotors
- Mathematical modelling and simulation
- Airworthiness and certification
- Space propulsion
- Wind turbines

The PhD program is hosted at the Department of Aerospace Science and Technology of Politecnico di Milano.

Director of the PhD course: Prof. Luigi Vigevano

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Info about program rules are available at the following web-page:
http://www.dottorato.polimi.it/en/during-your-phd/regulations/

PhD in Aerospace Engineering

Research Area n. 1 - Aerospace Engineering

Specific Research Subject: Orbit propagation and uncertainty modelling for planetary protection compliance verification

Scholarships and Financial support – Departmental scholarships	
Monthly net income of PhD scholarship (max 36 months)	€ 1.200,00
Number of scholarships	1
Deadline for applications	15/09/2016
Beginning of PhD	01/11/2016
Context of the research activity	
Motivations and objectives of the research in this field	The goal of this research is to develop efficient techniques to demonstrate that the planetary protection requirements are met for the European Space Agency (ESA) science missions, such as BepiColombo, JUICE and Libration Point Orbit missions. An efficient, accurate and robust technique for propagating interplanetary orbits in multi-body dynamics in presence of fly-bys will be developed exploiting semi-analytical techniques and close encounter representations. Tools for mapping the distribution of uncertain initial conditions or errors in the intermediate manoeuvre will be devised and applied to planetary protection compliance verification and to the robust design of interplanetary trajectories.
Methods and techniques that will be developed and used to carry out the research	The probability that rocket upper stages or spacecraft during science missions or at the end of their life will hit the Earth or any other protected body needs to be assessed. The Planetary Protection requirement is that the spacecraft or upper stage have a less than 10^{-4} chance of impacting planets and moons within 100 years after launch. To verify compliance to this requirement, the distribution of launcher injection errors or the uncertainty in the end-of-life manoeuvre or fly-by conditions need to be mapped over 100 year at least. This requires thousands of hundreds of single 100-year orbit propagations if a Monte Carlo approach is adopted. The use of a brute-force approach is a burden due to high computational time. To overcome this limitation, this project will develop novel techniques for the verification that a mission complies with planetary protection requirement. For the long-term propagation of highly-perturbed trajectories, an orbit propagator will be tuned such that objects in planet resonance can be integrated with small errors over many decades. Semi-analytical techniques will be developed to propagate the orbital elements during interplanetary missions also in presence of fly-bys. To demonstrate planetary protection compliance the likelihood of a collision event need to be assessed by using different representations of the close-encounter to characterise the impact conditions within an initial distribution without the need for orbit propagation. The envisaged framework will take advantage of methods to efficiently sample the initial dispersion and parallel programming techniques to massively reduce the required number of 100-year simulations. Programming skills in modern Fortran or C++ are preferred.
Educational objectives	The main educational objectives concern the achievements of capabilities in the development of techniques for trajectory propagation and uncertainty estimation for planetary protection compliance verification. These skills include numerical methods, orbital dynamics, parallel programming, statistics and optimisation. The candidate will also spend period of research visit at the European Space Agency in ESOC Darmstadt, applying the developed tools to current and planned space missions.
Job opportunities	Job opportunities are identified in the fields of mission analysis, flight dynamics, navigation, space situation awareness, control engineering.

Composition of the research group	Number of Full Professors: 1 Number of Associate Professors: 3 Number of Assistant Professors: 3
Names of the research director	Dr. Camilla Colombo
E-mail address, phone number and web-page	camilla.colombo@polimi.it
List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research	1. European Space Agency
Additional support	
Educational activities: financial aid per PhD student per year	1st year: max € 0 per student 2nd year: max € 1370 per student 3rd year: max € 1370 per student Additional travel funding are available within the research group.
Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD student	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.
Computer availability:	Individual personal computer and access to world-class high-performance computing, if necessary.
Desk availability:	1st year: *individual use* 2nd year: *individual use* 3rd year: *individual use*