In consideration of the determination of the Regione Piemonte – Direzione Coesione sociale No. 258 of May 20, 2021 which approved the following apprenticeship position for the PhD project proposal submitted by the Politecnico di Torino in the framework of a specific regional call for proposals (Apprendistato di Alta Formazione e Ricerca 2016-2018 - Avviso Pubblico per la realizzazione dei percorsi formativi di: Laurea triennale e magistrale, Diploma Accademico di primo e secondo livello, Master di primo e secondo livello Universitario, Dottorato di ricerca e Diploma accademico di formazione alla ricerca, Attività di ricerca approvato con Determinazione 537 del 3/8/2016 e s.m.i.):

**PhD in Aerospace Engineering**

**Research project “Metodi innovativi per lo studio di flussi turbolenti”**

**Politecnico di Torino – Optimad Engineering s.r.l.**

| Supervisor          | Prof. Francesco Larocca – Politecnico di Torino  
|                     | francesco.larocca@polito.it  
|                     | Dr. Haysam Telib – Optimad Engineering s.r.l.  
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| Contact             | [https://www.dimeas.polito.it/en/research/research_groups/aerospace_propulsion](https://www.dimeas.polito.it/en/research/research_groups/aerospace_propulsion)  
|                     | [http://www.optimad.it/](http://www.optimad.it/)  

**Context of the research activity**

Several problems in aerospace engineering are characterized by the presence of complex geometries and turbulent flows. Furthermore, there are configurations in which a body changes its shape or moves with respect to other components of the system. In this case the simulation of the flow field by means of classical body fitted CFD methods is challenging because of the intrinsic difficulties in generating and deforming the computational mesh. For this reason,
Immersed boundary techniques represent a valid alternative since they allow to describe the effects of a body on the fluid without the need of using a body-fitted mesh: the presence of the body is described by introducing additional terms in the governing equations. However, several problems in aerospace engineering are characterized by high Reynolds number flows: the description of the thin boundary layer observed in these working conditions is a challenge for immersed boundary methods. For these reasons, several research efforts are currently devoted to the development of new approaches for the description of high Reynolds number turbulent flows by immersed boundary methods. The candidate will investigate these problems in order to find solution which could have a significant impact in several research fields. The Company Optimad Engineering s.r.l. has planned for the winner of this position a collaboration within a contract of **high apprenticeship** according to the Italian Legislative Decree 81/2015, art. 45.

<table>
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<th>Objectives</th>
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<td>The goal of the research activity is the development of techniques for the simulation of turbulent flows in the presence of complex geometries. The PhD student will start the activity by learning the state-of-the-art for the simulation of high Reynolds number flows with hybrid RANS-LES methods. The next step will be focused on the integration of these approaches in the framework of immersed boundary methods. This will make it possible to study complex geometries and moving bodies. In order to reach this goal, it will be necessary to solve several problems related to the description of boundary layers in the framework of immersed boundary methods: the potential of new wall functions or alternative strategies will be investigated. The PhD student will be responsible for the implementation, testing and validation of these techniques and a significant portion of the time will be devoted to programming activities in order to introduce these approaches in a parallel CFD code. Finally, particular attention will be devoted to the validation of the results by comparing them with experimental data available in the literature: this will be a fundamental step to quantify the predictive capability and to obtain further improvements.</td>
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### Skills and competencies for the development of the activity

The candidate should have a good background in the numerical simulation of compressible turbulent flows in aerospace problems: the knowledge of the fundamental phenomena and the possible techniques to simulate these configurations represents a preferable background.

Furthermore, the research activity will be focused on the development of numerical codes and so the candidate should have a solid background in programming (C or Fortran): in particular, competencies in the implementation of numerical schemes for the integration of partial differential equations are particularly important.

The candidate shall be **less than 30 years old** at the moment of the hiring from the company.