

(BL36/2024)

### **Research Studentship for PhD student**

Applications are open for one Research Studentship, within the framework of project AEROFLEX (1018P.06469.1.01) AEROFLEX GRANT NUMBER FA8655-24-1-7377 - Instituto Superior Técnico, under the following conditions:

**Scientific Area:** Mechanical Engineering and Aerospace

#### **Admission Requirements:**

*a) To be enrolled at a PhD.*

*To have concluded a master's degree in aerospace engineering, aeronautics engineering, mechanical engineering or electrotechnics engineering.*

*b) To have knowledge in Aerodynamics, Propulsion, Heat Transfer, Aeroelasticity and Optimization.*

*To have knowledge in Programming languages such as Matlab, Python, C++...*

#### **Workplan:**

### **PhD on the design of aeroelastic scaling strategies for flexible wing Research project with the USAF (United States Air Force)**

Applications are welcome to a PhD research position in the Aerospace Engineering, at Técnico Lisboa, Portugal. You will be working as part of the Aerospace Research Group, under the supervision of prof. Afzal Suleman and prof. Fernando Lau. The group is growing and seeking highly motivated PhD candidates who wish to pursue research in the areas of aircraft and space vehicle design, aeroelasticity and multidisciplinary design optimization. We're looking for people driven by excellence, excited about innovation, and looking to make a difference. If this sounds like you, you've come to the right place!

As wings become slenderer to improve aerodynamic performance, they become more prone to undergo aeroelastic phenomena that might have not been well studied. Thus, it is of extreme importance to analyze these phenomena in reduced scaled prototypes specially conceived for wind tunnel and/or flight tests. However, to do so, we need to devise aeroelastic scaling strategies capable of replicating the aeroelastic behavior of the full-scale model in the reduced scale prototype. Optimization techniques, such as topology optimization for additive manufacturing and aerodynamic shape optimization to control aerodynamic loads through outer surface, are envisioned as enabling tools for designing aeroelastically scaled prototypes. With this in mind, this PhD scholarship is focus on 3 main tasks: (i) develop aeroelastic scaling methodologies; (ii) build prototypes designing with the developed scaling strategies; and (iii) test these prototypes in wind tunnel and eventually in-flight to evaluate the aeroelastic behavior.

The potential applications of scaled flight test demonstrators to evaluate the aeroservoelastic performance of novel aircraft configurations using reduced dynamic response have attracted considerable attention in the aerospace industry. Full scale models are scaled down to reduce the experimental validation and evaluation costs. The flight test models may be manufactured using multi-material additive manufacturing techniques. To this end, dynamic and aeroelastic scaling using multi-material topology optimization is proposed. The optimization tool distributes materials within a structure to achieve the reduced eigenvalues and eigenvectors, while ensuring its manufacturability. The design domain would be a scaled model of the real full scale and it should have similar dynamic behavior as the full scaled models. The desired eigenvectors of the scaled models will be tracked by adding

the modal assurance criterion as additional constraints in the formulation optimization. The continuous path planning will also be integrated into the multimaterial topology optimization for dynamic scaling to be employed in multi-material additive manufacturing.

The following aspects will be considered: (i) Computational efficiency of matching the reduced natural frequencies for the reduced scale model compared to the full scale one; (ii) feasibility of manufacturing using 3D printing the reduced scale structure using topology optimization; and (iii) validate and evaluate the computational results for the optimal structure with experimental results for the 3D printed model.

## RESEARCH PLAN

Task 1: Development of dynamic and aeroelastic scaling methodologies and application to a representative lifting surface [Year 1]

Task 2: Development and application of a topology optimization methodology with dynamic scaling and manufacturing constraints. [Year 1-2]

Task 3: Development of multi-material topology optimization constrained for the desired dynamic behaviour based on additive manufacturing techniques. [Year 2-3]

Task 4: Proof-of-concept design, wing manufacturing using additive manufacturing techniques based on topology optimization results, instrumentation, wind tunnel testing and validation of a representative lifting surface to verify performance. [Years 3-4]

Qualifications: You should possess preferably a MSc degree or equivalent in Aerospace Engineering; candidates with a degree in Mechanical Engineering or Electrotechnical Engineering can also apply.

Programming Skills: Experience with programming software such as Matlab, Python or C++.

Language Skills: Fluent written and verbal communication skills in English are required.

**Legislation and Regulations:** Statute of Scientific Research Fellow, approved by Law nr. 40/2004, of August 18, as worded by Decree-Law nr. 123/2019, of August 28; FCT Regulation for Research Studentships and Fellowships, available on <https://www.fct.pt/apoios/bolsas/docs/RegulamentoBolsasFCT2019.pdf> and <https://dre.pt/application/file/a/127230968>.

**Workplace:** The work will be developed at Department of Mechanical Engineering of Instituto Superior Técnico, under the scientific supervision of Profs. Afzal Suleman and Fernando Lau

**Duration:** The research fellowship(s) will have the duration of 12 months. It's expected to begin in August 2024, and may be eventually renewed up to the maximum of 48 months.

**Monthly maintenance allowance:** According to the values for Research Fellowships awarded by FCT in Portugal ([https://www.fct.pt/wp-content/uploads/2024/02/Tabela-de-Valores-SMM\\_atualizacao-2024.pdf](https://www.fct.pt/wp-content/uploads/2024/02/Tabela-de-Valores-SMM_atualizacao-2024.pdf)), the amount of the monthly maintenance allowance is € 1 259.64, being the payment method an option of the Fellow by Wire Transfer/Check.

**Selection methods:** The selection methods will be the following: Curriculum evaluation: 75% and Individual interview: 25%

**Composition of the selection Jury:** prof. Afzal Suleman, prof. Fernando José Parracho Lau and Prof. Frederico José Prata Rente Reis Afonso.

**Announcement/ notification of the results:** The final evaluation results will be communicated to all applicants by email.

**Application deadline and formalization:** The call is open from March 26 until July 12, 2024.

It is mandatory to formalize applications with the submission of the following documents: i) B1 Form – Fellowship application (<https://drh.tecnico.ulisboa.pt/bolseiros/recrutamento/>); ii) *Curriculum Vitae*; iii) academic degree certificate, where applicable; iv) proof of enrollment at an academic degree course (PhD); v) motivation letter;

Applications must be submitted to the email: [lau@tecnico.ulisboa.pt](mailto:lau@tecnico.ulisboa.pt)