Thermo Fluid Dynamics Systems and Microsystems R&D

etsiae UPM

RESEARCH JOB OPPORTUNITY

The Thermo-Fluid Dynamic Systems and Microsystems Research Group (ETSIAE UPM, Madrid), is looking to incorporate to its research team a **post-graduate engineer (master degree or near to finish the master degree)** to participate in the scientific project A NOVEL EXPERIMENTAL APPROACH TO FLOW STRUCTURE INTERACTION PROBLEMS IN WIND TURBINE BLADES UNDER SEPARATED FLOW CONDITIONS (FSI-BLADE), TED2021-132378B-I00, funded by the AEI, during a minimum timespan of two years.

What is looked for?

The candidate should have:

- Strong background in Fluid Mechanics, Solid Mechanics (Vibrations), and Mathematics.
- Excellent/good academic record.
- Programming skills (Matlab/C/fortran).
- Social skills for teamwork.

Main tasks to do:

- Experimental studies in a water channel of flow-induced vibrations (FIV) of elastic models of wind turbine blades: planning of experiments, data acquisition, and data reduction.
- Find conditions (say critical wind speed, wind incidence) where FIV are prone to appear. Proposition of mitigation strategies.
- Development or reduced order mathematical models.
- Writing scientific reports and papers.

What is offered:

- Research will be held in a professional fluid/solid mechanics scientific lab: medium size water channel, PIV equipment, Sensors (force, displacement), actuators, lasers, 3D printing machines, cluster of computation, office with personal computer.
- Salary: 24500 Euros/year.
- Dedication: 37.5 hours/week.
- Immediate incorporation.

Interested people, please send an email (including CV) to antonio.barrero@upm.es and/or angel.velazquez@upm.es.

RESEARCH PROJECT DESCRIPTION

Background, motivation, and main objective

The size of modern wind turbines is, because of economy of scale factors, increasing to limits that were not deemed to be practical a couple of decades ago. One of the design consequences of this trend of continuously increasing size is that blades are becoming critically slim and far more flexible. The design of these new types of flexible, low stiffness, blades require that **Fluid Structure Interaction FSI** (aero-elastic) aspects need to be accounted for from the outset. They are important during operation at on-design conditions because they may decrease the turbine power output; but they may be critical at off-design operation (with separated flow) because they may cause severe damage to the blade. In fact, a significant number of recent wind turbine worldwide accidents that were labelled as of "unknown origin" at the first damage review were ascribed, after a detailed analysis, to the "FSI induced" category.

The **main objective** is to gain new experimental knowledge on the problem of flow-structure interaction/flow-induced instabilities that appear in large wind turbines blades under separated flow conditions. The expected practical outcome being to devise methods to alleviate operation problems in off-design conditions.

Methodology

The project will make an extensive experimental campaign guided by dimensional analysis. Its phases are:

- **Phase 1**: Study of the dimensionless flow vortex shedding frequency from the blade as a function of both the flow angle of attack and blade geometry.
- **Phase 2:** Study of the cross flow-induced oscillations for the same reference blade. Dimensionless governing parameters to be considered are blade geometry, reduced velocity, mass ratio, dimensionless structural damping, and angle of attack.
- **Phase 3:** Further testing of the critical cases of Phase 2.

The experiments will be carried out at the recirculating water channel of the Research Group premises in the School of Aeronautics at the Technical University of Madrid (UPM). Its main dimensions (length, width, height) are 5.2 m × 3.2 m × 1.8 m, and it contains 15 m^3 of water. The dimensions (length, width, height) of the test section are 3.0 m × 0.9 m × 0.8 m. The walls of the test section are made of tempered glass to allow for visual access from several directions. Mean flow velocity can be varied, in a controlled way, in the range from 0.025 m/s up to 1.2 m/s. Accordingly, the Reynolds number, based on the channel width, can be varied between 20×10^3 and 1×10^6. The project will consider a blade specifically developed for R&D purposes by the National Renewable Laboratory, NREL (USA). This 62 m long blade has a mass ratio of m*=30 and a non-dimensional mechanical damping of b*= 0.0048. Both values will be prescribed in the experiments since our experimental set-up allows for control of mass and damping. Regarding the Reynolds number complete similarity, at a first approach there is no need to consider it since we will address flows with massive separation, and, in these cases, the Reynolds number dependence is weaker.