PhD in MECHANICAL ENGINEERING

Research Title: Dynamic Analysis of Mistuned bladEd Disk with friction contact - DAMNED

Funded by	ANSALDO Energia

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Context of the research activity	Mistuning is a lack of symmetry present in real objects that ideally are perfectly symmetric. This phenomenon was also observed in turbine disks and it can cause an increase of the forced response bringing about unexpected fatigue failures. Mistuning is caused by manufacturer tolerances, non-homogeneity of the material, wear, etc., and so it is unavoidable. In bladed disks mistuning is also coupled with blade rows aerodynamics and the effect of this combination is difficult to predict. Even though airfoils may eventually become aerodynamically unstable, the vibration amplitude is ultimately limited by damping devices exploiting dry friction, snubbers for example. The details about how the dry friction influence the mode-shapes is not fully understood, and thus it is today not possible to predict with accuracy the forced response of bladed disk.

Objectives	The main objective of this research activity is to develop and validate of efficient and accurate modeling techniques for the nonlinear dynamics of mistuned bladed disks with friction contacts. This activity includes both numerical and experimental tasks. In the numerical task a reduced or simplified model of the bladed disk is developed. In this model the degrees of freedom not involved in the inter-blade coupling are eliminated. Moreover, during the numerical activity a proper contact model is put forward. Methods for fast nonlinear forced response of mistuned disks are also developed. The experimental task aims to test the effect of mistuning on a rotating disk. Rotating rig experiments are performed with the facilities (spin rig, simplified disks, and instrumentation) present in the AERMEC laboratory in DIMEAS. Different mistuning patterns are tested, such as alternating, random, and so on. The expected result is a design tool capable to predict the dynamics of a mistuned disk in presence of contact among blades. The definition of an optimal mistuning pattern is also expected.

Skills and competencies for the development of the activity	The successful candidate is highly interested in topics related to turbines and bladed disks. The applicant is familiar with numerical modal analysis and one-dimensional/three-dimensional models of turbine blades. Essential skills are a very analytical mind, questioning and problem-solving ability. The candidate has the capability to deeply investigate, both theoretically and experimentally, the given problem. Good capability to accomplish an experimental job are also needed. Important skills are an advance knowledge of computational software (MATLAB, PYTHON), CAD software (SOLIDWORKS) and finite element tools (ANSYS). Interpersonal skills are desirable.