ALL. B

SCHEDA PER LA RELAZIONE ANNUALE DEL DOTTORANDO CICLO 34 Anno FIRST

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- Area Culturale di Interesse (in Italiano e Inglese)
- *Increasing Safety of turbine disk*

- Breve descrizione dell'argomento della tesi o dell'Area Culturale di Interesse (massimo 20 righe, in Italiano e Inglese)

In the design of gas turbine engines deformation caused by vibrations must be reduced below a reasonable level. As a matter of fact, due to high levels of dynamic stresses, these vibrations can lead to failure of some components or of the entire engine. Despite the great advance in disk design, the problem of evaluating dynamic stresses at the design stage of gas turbine engines is currently an open issue.

One way to reduce dynamic stresses is to include devices that add friction damping into the mechanical system. This additional damping reduces the vibration amplitude of the blade and consequently decreases the dynamic stresses. Dry friction is one of the most important sources of damping in bladed disks. The frictional forces arise on the contact surfaces between different parts of the assembly. For example, on contact surfaces in the joint root, on contact surfaces of shrouds of the blades, and contact surfaces of friction dampers. Moreover, these frictional forces have a highly nonlinear behavior. This nonlinear behavior is more evident when the normal contact load is variable, when gaps close and open of gaps during the vibrations, etc. In this regard, engineers must have a reliable mathematical model of the contact interface to determine the dynamic stresses in the bladed disks at the design stage of gas turbine engines. These models must be sufficiently precise to simulate the energy dissipation effect during the operating conditions. The development of such models is a very important scientific and applied physic problem. An additional issue is that the real disk that cannot be simulated under cyclic symmetry conditions. Dimensional and geometrical tolerances and material non-uniformity introduce small variation on the sector geometry and mechanical properties that have a detrimental impact on the dynamic response of the disk. This phenomenon is known as "mistuning".

The primary steps of the research were focused on the literature review in the area of dynamic identification of nonlinear rotating system components like disks and blades. It was tried to know more about concepts like mistuning and its effects on dynamics of a rotating system. Also, primary theoretical concepts like cyclic symmetry for force and free vibrations analyses and transient and stationary responses detection in a rotating tuned bladed disc system were investigated. In addition, the modal analysis based on hammer testing techniques were studied as the experimental part of the work. Then, the experimental and theoretical concepts were applied to determine dynamic characteristics of a low-pressure turbine rig blade disk designed and tested by Avio. Based on experimental data and a wide range of simulations in ANSYS the identification process was performed, and the parameters of the tuned and mistuned blades were determined. After the identification, it was tried to model the mistuned system by taking into account a perturbation in parameters of a tuned system by using ANSYS and MATLAB simultaneously. As a result, a notable part of the research work was devoted to go through the reduction approaches to represent the dynamics of the full bladed disk in a simplified mathematical representation. The preliminary results of the reduced model of the blade shows adequacy of this simplified model for using instead of a full blade to lower the computational costs. The preliminary results were used as a guideline to do reduction for the full disk and assemble the reduced order models of blades and disk. Also, the effects of the contact between the blade and disk as a source of nonlinearity in the system were studied widely in the simulations. It was tried to find a model for the contact between the blade root and disk based on simplification of contact geometry and mutual contact force configuration.

- Attività di formazione svolta nell'anno (corsi, seminari, etc.); per ogni attività specificare natura, durata e sed

  Modeling of full film lubricated systems
  Numerical Modeling and simulation

- Eventuale partecipazione del Dottorando ad ulteriori attività di ricerca nell'anno (progetti e convenzioni di ricerca)

- Eventuale partecipazione del Dottorando ad Attività interne di supporto alla didattica nell'anno (specificare su quali corsi, e se eventualmente il Dottorando sia stato nominato Cultore della Materia)

- Eventuali soggiorni presso altri Centri di Ricerca nell'anno

- Eventuali collaborazioni con imprese nell'anno

- Elenco delle Pubblicazioni del Dottorando

Torino,

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Firma del Dottorando

Il Coordinatore
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