Nonlinear Dynamics of Turbine Bladed Disks with Friction Contacts: Development of Reduced Order Models

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Mechanical Engineering – Cycle XXXII

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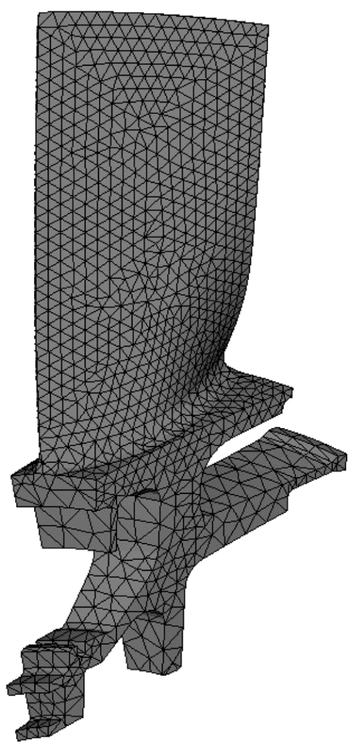
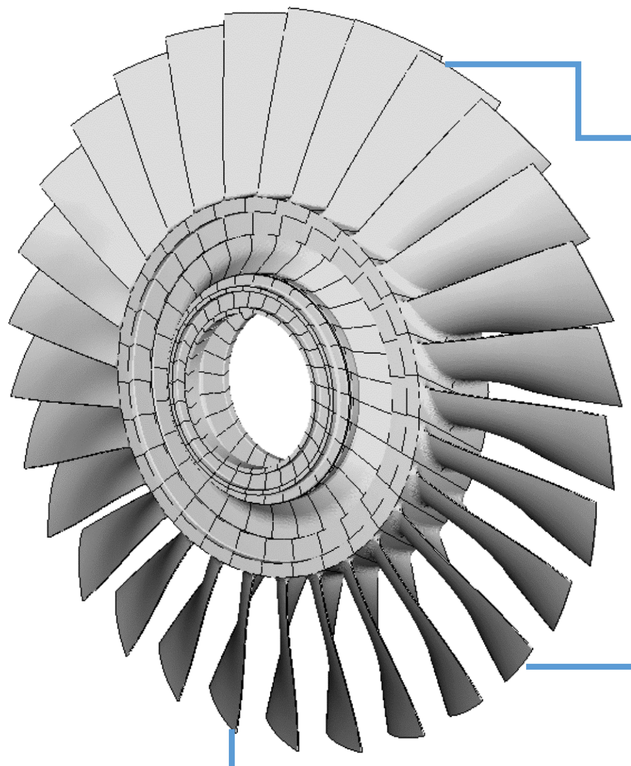
Turbine Bladed Disk





❖ ***Turbo machinery; Real-life and Industrial***

- *Persisting concern : Development of efficient, reliable and accurate models*
- *Realistic design and simulation is **challenging**, due to:*
  - *Mistuning (structural irregularities and absence of cyclic symmetry properties)*
  - *High modal density and unavoidable resonances in operating frequency range*
  - *High cyclic fatigue (HCF)*
  - *Dealing with highly refined FE models*
  - *Localization*

❖ ***Why Nonlinear Forced Response Analysis?***

- *Intrinsic nonlinearity due to friction at component interfaces*
  - *Shrouds*
  - *Under platform dampers*
  - *Fir tree root joints*

❖ ***Why Reduced Order Modeling?***

- *Full FE model analysis is numerically expensive*
- *Multiple simulations for statistical analyses (mistuning analysis)*
- *Time constraints for design phase*

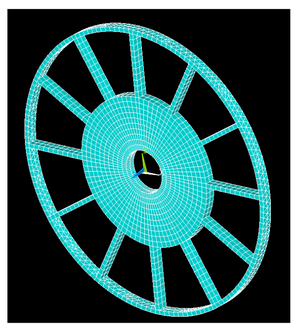
❖ ***Requirements***

- *Component mode synthesis techniques*
  1. *Craig-Bampton (CB)*
  2. *Rubin*
  3. *Mode Acceleration*
  4. *Dual Craig Bampton*
- *Harmonic Balance Method*
- *Alternative frequency/time approach*
- *Contact mechanics*
- *Cyclic symmetry properties*
- *Statistical simulations (Monte Carlo)*

A New Reduced Order Modeling Technique

❖ ***Objectives***

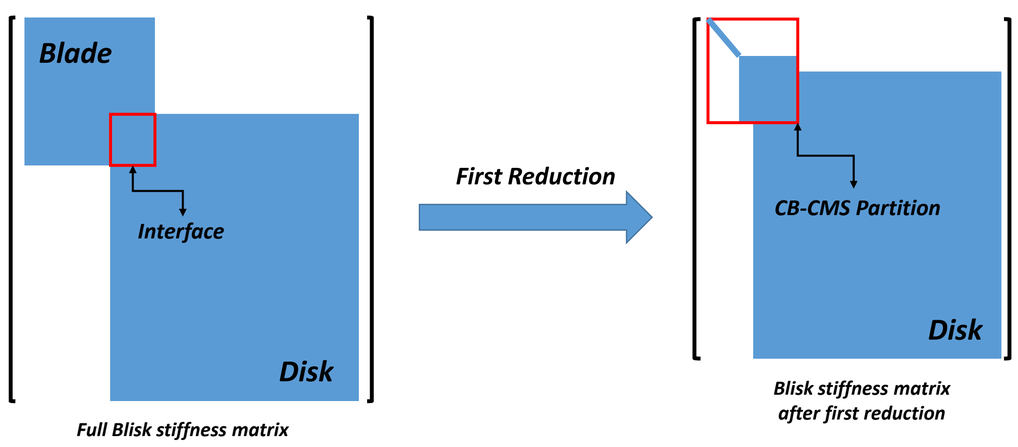
- ***Sector level computations***
- ***Introduce mistuning after reduction***
- ***Computationally cheap and efficient***
- ***Accurate and reliable***



Academic Bladed Disk

❖ ***Methodology***

- ***First Reduction : CB-CMS applied to the blade sector***
- ***Secondary modal reduction applied to the disk sector***

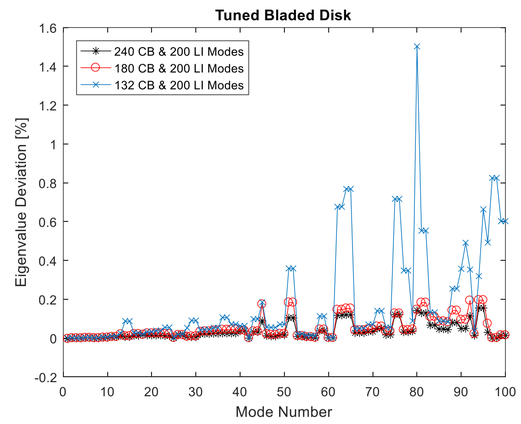


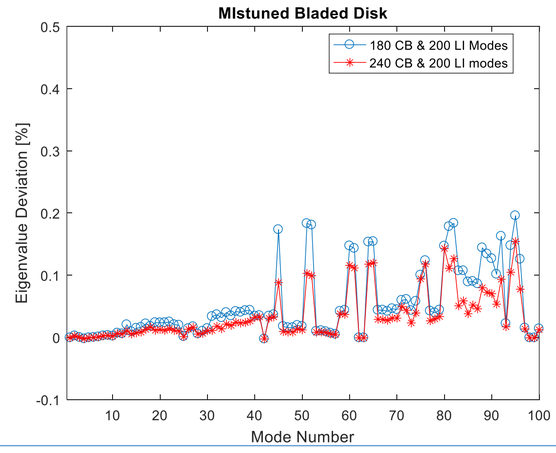
Full Blisk stiffness matrix

Blisk stiffness matrix after first reduction

Final Blisk stiffness Matrix

Preliminary Results





Publications

1. S. Mehrdad Pourkiaee, Stefano Zucca, ”***A reduced order model for mistuned bladed disks with friction contacts***”, Turbo EXPO 2018, *Abstract Submitted*.

Courses

1. Models and Methods for the Dynamics of Mechanical Components with Contact Interfaces
2. Advanced Aspects of the Finite Element Method
3. Public Speaking I
4. Communication I
5. Project Management
6. Communication II