Announcing the Final Examination of Alex Torkaman for the degree of Doctor of Philosophy

Time & Location: October 23, 2018 at 3:00 PM in ENG2 202A
Title: FLUTTER STABILITY OF SHROUDED TURBOMACHINERY CASCADES WITH NONLINEAR FRICTIONAL DAMPING

Prediction of flutter in shrouded turbomachinery cascades is difficult due to i) coupling of aerodynamic drivers and structural dynamics of the cascade through shrouds, and ii) presence of nonlinear dry friction damping as a result of relative motion between adjacent shrouds. An analytical framework is developed in this dissertation to determine flutter stability of shrouded cascades with consideration of friction damping. This framework is an extension to the well-established energy method, and it includes all contributing factors affecting stability of the cascade such as aerodynamic excitation and the stabilizing effects of dry friction damping caused by nonlinear contact forces between adjacent blades.

This framework is developed to address a shortcoming in current analytical methods for flutter assessment in the industry. The influence of dry friction damping is typically not included due to complexity associated with nonlinearity, leading to uncertainty about exact threshold of flutter occurrence. The new analytical framework developed in this dissertation will increase the accuracy of flutter prediction method that is used for design and optimization of gas turbines.

A hybrid time-frequency-time domain solution method is developed to solve aeroelastic equations of motion in both fluid and structural domains. Solution steps and their sequencing are optimized for computational efficiency with large scale realistic models and analytical accuracy in determining nonlinear friction force. Information exchange between different domains is used to couple aerodynamic and structural solutions together for a comprehensive and accurate analysis of shrouded cascade flutter problem in presence of nonlinear friction.

Example application to a shrouded IGT blade shows that the influence of nonlinear friction damping in flutter suppression of an aerodynamically unstable cascade is significant. Comparison with engine test data shows that at observed vibration amplitudes in operation friction damping is sufficient to overcome aerodynamic excitation of this aerodynamically unstable cascade, resulting in overall cascade stability.

Major: Mechanical Engineering

Educational Career:
Bachelor’s of Mechanical Engineering, BS, 1996, Florida Atlantic University
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Approved for distribution by Jeffrey L. Kauffman, Committee Chair, on September 14, 2018.

The public is welcome to attend.