Announcing the Final Examination of Andrew John Del Rio for the degree of Master of Science

Time & Location: April 15, 2020 at 10:00 AM in N/A -virtual Skype
Title: Viscoelastic Analysis of High Strain Composites for Deployable Structures in Space Applications

Thin-ply composite laminates capable of enduring high strains are currently under investigation for compliant deployable spacecraft structures. Deployable structures such as booms fabricated from these materials can be flattened and coiled to high curvatures, achieving a highly compact configuration for stowage. Once in orbit, they are released with minimal actuation for deployment, allowing the operational geometry to be recovered. Previous studies have shown that the viscoelastic properties of the composite epoxy matrix can negatively impact final shape accuracy due to stress relaxation during stowage. In addition, since the strain energy stored is relied upon for deployment, considerable relaxation can potentially result in deployment stall. Stress relaxation in composites and the aforementioned effects it can have on deployment have not been analyzed sufficiently for space applications. The objective of this thesis is to implement and validate a finite element method to incorporate relaxation properties of composites using commercially available software. The viscoelastic Kirchhoff plate model that serves as the theoretical basis of the analyses is first presented. An analytical solution for the recovery of a composite plate after stowage are derived. The numerical integration of the viscoelastic plate constitutive equations and its implementation as a user-defined subroutine in finite element programs is then described. The subroutine allows relaxation of 3D thin-shell structures to be modeled is applied to simulate stowage and recovery of a deployable boom currently of interest for solar sailing applications. The subroutine is then compared with results obtained from experiments for a thin-ply composite for bending relaxation and curvature creep recovery after being unloaded.

Major: Aerospace Engineering

Educational Career:
Bachelor's of Aerospace Engineering, BS, 2018, University of Central Florida

Committee in Charge:
Kawai Kwok, Chair, Mechanical and Aerospace Engineering
Jeffrey Kauffman, Co-Chair, Mechanical and Aerospace Engineering
Yuanli Bai, Mechanical and Aerospace Engineering Department

Approved for distribution by Kawai Kwok, Committee Chair, on March 30, 2020.

The public is welcome to attend.