College of Engineering
Department of
Mechanical & Industrial Engineering

The Robert W. Courter Seminar Series

3:00-4:00pm, Friday, March 19th, 2021

ZOOM: https://lsu.zoom.us/meeting/register/tJApd-mhqzssHNAtbx8xlujIXfCf28JLgcJB

Coupled flight dynamics and thermoelasticity model of maneuvering aircraft in an undeformed body frame

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The stress and strain tensors in maneuvering aircraft are effected not only by the aerodynamic and propulsive forces but also by the body translational and angular velocities and high rate temperature distributions. The structural design of flexible aircraft requires the elastic fields to be evaluated at high accuracy, and new models which couple the aeroelasticity equations with the heat and translational and rotational equations of flight dynamics are essential. On the other hand, to advance control design of hypersonic platforms and flexible aircraft and missiles, it is necessary to derive and employ new governing equations of flight dynamics which couple the classical rigid body flight dynamics equations with the elasticity and heat equations.

This talk concerns modeling of flying flexible aircraft in an undeformed body frame. The model is derived from the first principles and is based on the Euler-Lagrange equation with respect to four invariants, the kinetic energy, the gravitational potential energy, the generalized free energy, and the dissipation function. The generalized coordinates comprise the inertial coordinates, the Euler angles, the elastic displacements, and the three components of the entropy flow. The model results in ten coupled equations, six translational and rotational equations which couple the six rigid body translational and angular velocities with the three elastic modes, and four dynamic thermoelasticity equations which couple the elastic modes and temperature with the rigid body modes. Particular cases of longitudinal flight of an elastic transport and motion of a thermoelastic beam are analyzed. In addition to continuum mechanics equations we derive structural dynamics equations which couple structural modes and nodal temperature with rigid body translational and angular velocities.

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