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Master Thesis Defense

Entitled

BENDING-TORSION FLUTTER ANALYSIS OF A VISCOELASTIC TAPERED WING CARRYING AN ENGINE AND SUBJECTED TO A FOLLOWER THRUST FORCE

by

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Date & Venue

8:00 pm
Monday, 19 April 2021
Microsoft Teams
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Abstract

Flutter, a dynamic divergent instability, is one of the significant phenomena of Aeroelasticity. This dangerous aeroelastic phenomenon can occur to any flexible structure subjected to aerodynamic forces such as aircraft wings, bridges, buildings, etc. It is important to analyze the flutter in order to predict the speed and frequency at which it occurs so that structural damages and failures can be avoided. This thesis is concerned with non-dimensional parametric modelling of the flutter of a viscoelastic tapered wing with an attached engine. The main objectives of this thesis are to determine regions of stability and boundaries of flutter speed and frequency and to examine how various parameters, such as engine thrust and mass, engine location, taper ratio, and the viscoelastic damping, impact the flutter characteristics of the wing. The wing is considered as a cantilever tapered Euler-Bernoulli beam, made of a linear viscoelastic material where Kelvin-Voigt model is assumed to represent the viscoelastic behavior of the material. The wing is subjected to aerodynamic forces as well as a follower thrust force generated by the engine. Quasi-steady and unsteady assumptions are employed to model the aerodynamic forces. The governing equations of motion are derived through the extended Hamilton's principle. The resulting partial differential equations are solved via Galerkin's method along with the classical flutter investigation approach. The study reveals that a tapered wing would be more dynamically stable than a uniform wing. It is also observed that the viscoelastic damping provides wider stability region for the wing. The investigation shows that the engine thrust and mass have significant effects on the dynamic stability of the wing. The investigated system interactions induce aeroelastic instabilities as the system parameters exceed their certain critical values. The developed model could precisely predict the flutter condition. The obtained theoretical predictions are explained based on real-life cases to give a better understanding of the flutter phenomenon.

Keywords: Aeroelasticity, flutter, viscoelastic wing, follower force, Kelvin-Voigt model, Galerkin's method, Theodorsen's aerodynamic model.