Course: AE 451 - Aeroelasticity

Credit and contact hours: 3 undergraduate hours, or 1 graduate unit with project
Lecture: 2 meetings/week for 100 minutes/meeting

Instructor: Lawrence A. Bergman

Textbook(s) and/or other required material:

Instructor's notes
Theory of Wing Sections, Abbott and Doenhoff, Dover Publications

Course description:

An introduction to linear aeroelasticity, covering aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles. Topics include divergence of linear elastic lifting surfaces; vibration of discrete and continuous systems; effect of elastic deformations on lift distributions and stability; flutter of linear elastic straight and swept wings employing both discrete and distributed models; introduction to stochastic processes; dynamic response to gust loads and continuous atmospheric turbulence.

Prerequisites: AE 323 and AE 352, or equivalent

Designation: Elective

Specific goals for the course:

Specific outcomes of instruction:

- Calculate bending and torsion deflections for flexible wings (straight and swept) as well as divergence, control reversal, flutter, etc. for aeroelastic coupled configurations
- Design a lifting surface under aeroelastic quasi-static dynamic load

Course outcomes (Brackets refer to program outcomes from ABET Criterion 3):

- Solve integral and differential equations modeling aerodynamic forces acting on wing structures in bending and twisting [a]
- In the context of constructing mathematical models from data, the students are introduced to the concept of system and parameter identification [b]
- In the discussions of strategies for vibration and shock isolation and absorption, we present and analyze various strategies and outline the design problem. In the section of the course dedicated to wing flutter, we discuss and analyze strategies for placing the stability boundary. Safety and sustainability issues are discussed throughout the course. [c]
- The relevance of concepts introduced in this course to the greater challenge of designing and building an aircraft in a multi-disciplinary environment are stressed throughout. [d]
- Integration of aerodynamic and solid mechanics concepts [e]

- Lectures often refer to solutions of actual problems encountered in industry, where solutions were constrained by economic, environmental and social considerations [h]
- Examples often conclude with a discussion of limitations on the quality of the solution, and advanced methods needed to do better [i]
- The students must be able to solve PDEs and ODEs as well as integral equations [k]

List of topics:

- Vibration of discrete and continuous systems. Resonance, damping (3)
- Steady-state aeroelastic phenomena. Divergence, loss and reversal of control, effect of deformations on lift distributions and flight stability (14)
- Elastic flutter. Fundamentals, single and multi-degree-of-freedom flutter, flutter of a continuous wing (17)
- Panel and shell flutter (2)
- Transient phenomena. Time and motion-dependent forces, landing, gusts (5)