EAS 6939: Special Topic in Aerospace Engineering; Aeroelasticity I
Spring 2021
Mechanical & Aerospace Engineering Department
University of Florida

1. **Catalog Description:** (3 credits) Graduate Level Introduction to Aeroelasticity
2. **Desired Background:** Statics, Dynamics, Strength of Material, Basic Vibrations, & Basic Aerodynamics, Proficiency in MATLAB, Highly Desirable Course: EGM6934 Structural Dynamics
3. **Course Objectives:** This course is designed to establish the fundamentals of interaction between an airframe and the aerodynamics forces. The students will learn to formulate the equations of motion for static as well as dynamic stability of the fixed-wing aircraft.
4. **Contribution of Course to Meeting the Professional Component:** This course introduces the aspects of coupling between structure and aerodynamics that are considered critical for pushing the flight envelope of an air vehicle. Aeroelasticity is a specialization topic that requires knowledge in multiple disciplines such as statics and structural dynamics analysis, steady and unsteady aerodynamics and complex formulations of dynamic equations of motion.
5. **Course Outline:** Aeroelasticity pertains to the study of interaction among the three disciplines of aerodynamics, elastic structure, and inertial properties. The interaction between aerodynamics and elastic structure results in the structural deformation which may affect the aerodynamic performance and further may lead to static instabilities such as control reversal and divergence. By introducing inertial properties to the mix, there is a potential for dynamic instability called flutter. In order to build up to the static and dynamic instabilities, some of the fundamental concepts of structural dynamics will be studied leading to the formulation of the dynamic equations of motion. Simplified concepts of unsteady aerodynamics will be introduced to formulate the flutter equations of motion for a 2 degrees-of-freedom typical section wing model followed by extension to a restrained wing using strip theory. Various methods of solving the flutter equations will be studied.
6. **Instructor:** Dr. Vin Sharma
   Email: vin.sharma@ufl.edu
   Students are encouraged to contact me via email. I grade the assignments so I become familiar with my student's strengths and weaknesses.
7. **Class Schedule:** This course will be taught at the REEF in Ft. Walton Beach, T & Th, 2:30-4:00PM. The lectures are to be video recorded and made available through EDGE.
8. **Topics of Study:** The following topics are listed as a general guideline. The actual topics and their order of study may be changed**.**
   - Overview of aeroelasticity: Demonstration of flutter using a 2-D wing model; Introduction to structural analysis, Introduction to static and dynamic aeroelastic instabilities

- Formulation of equations of motion of wing: Wing bending and torsion, Static and Dynamic response analysis
- Static aerodynamics: Static deflection and aerodynamic performance, Static divergence, Control reversal, Wing flexibility for flight control, structural optimization for static divergence
- Unsteady aerodynamics: Theodorsen function unsteady aerodynamics, Added mass effects, Wagoner function, Phase between aerodynamic forces and lifting surface motion
- Formulation of flutter equations of motion: Aerodynamic influence coefficient matrix, simplification of flutter equations of motion
- Flutter analysis: Complex eigenvalue and eigenvector solution, Two-degrees of freedom wind section and extension to multi-degrees of freedom wing
- Introduction to aeroservoelasticity
- Review of flutter analysis techniques in the Aerospace Industry
- Individual Project:
  - Design of a cantilevered wing flutter model

9. **Textbook and software Requirement:** Course material is collected from various sources. No specific textbook required is for this course. Following references will be extensively used:
   - Introduction to Aircraft Aeroelasticity and Loads, Wright, J.R. and Cooper, J.E., John Wiley and Sons Inc., 2007
   - Introduction to Structural Dynamics and Aeroelasticity, Pierce and Hodges, Cambridge University Press, 2002
   - An Introduction to Aeroleasticity, Fung, Y.C., John Wiley and Sons Inc., 1955
   - Theoretical and Computational Aeroelasticity, Rodden, W.P., Crest Publishing
10. **Attendance and Expectations:** Students local to the REEF are expected to attend every in-class lecture. The recorded lectures should be available for viewing the same day.
11. **Grading Policy:** The students will be required to demonstrate a sound understanding of the concepts presented in the lectures, through homework assignments and a final project. These assignments will require theoretical formulations and numerical solutions using **MATLAB**. By taking this course you have expressed a strong desire to learn a new subject and reasonable attempt will be made to accommodate each student.

    50% HW assignments
    30% One take-home exam
    20% Project

    Untidy submittals will be rejected

Grading scale:	91 - 100	A
	75 - 90	B
	50 - 74	C
	40 - 49	D