AEROSPACE
SHORT COURSES

Principles of Aeroelasticity (AERO0410)

Instructor: Thomas Hermann

Course Description

This course is designed to provide a qualitative understanding of aeroelastic behavior for aerospace vehicles. The class will explore different forms of aeroelastic phenomena and associated issues in structural dynamics and aerodynamic-structure interaction. Topics include solution methodologies, computational methods for aeroelastic analysis, development of the operational flight boundary, aeroservoelasticity, and contemporary topics such as limit cycle oscillations and related nonlinear pathologies in aeroelastic systems. The class addresses practical issues such as ground and flight tests. The course material will require selected study of the essential equations.

Course Highlights

- A brief overview of history, definitions and fundamentals
- Description of static aeroelastic phenomena, including divergence and reversal
- Review basic mechanical vibration theory leading to modal methods
- An introduction to unsteady aerodynamics
- An introduction to dynamic aeroelasticity
- The development of the governing equations for the aeroelastic system
- The pros and cons of frequency domain versus time domain methods
- Flutter identification and review of flutter models
- Development of the flutter boundary, federal regulations and application to the flight envelope
- Example problems used to elucidate concepts
- Ground tests, GVTs and wind tunnel tests
- Aeroservoelasticity for response mitigation and flutter alleviation
- Flight test program examples
- Nonlinear aeroelasticity

Who Should Attend?

This course is designed for engineers and technical managers involved in aerospace vehicle design, analysis and testing related to aeroelastic response and stability issues. The level of class instruction is appropriate for engineers and managers with an undergraduate degree in engineering.

Learning Objectives

- Concepts of static aeroelastic phenomena, such as divergence and reversal

- The building blocks for aeroelasticity – the vibrating wing and unsteady aerodynamics
- Distinct features of aeroelasticity: static vs. dynamic, stiffness vs. strength, response vs. stability
- The basics of vibration theory and modal methods as needed for aeroelastic analysis
- The underlying physics associated with vibrations of the aerospace structure, the unsteady aerodynamics, and the interaction of these loads
- The recognizable characteristics of flutter
- The classical and current methods of flutter analysis
- Steps to develop a ground test program for aeroelastic characterization
- Steps to develop a flight test program to qualify the aeroelastic characteristics of the vehicle

Course Outline

Day One

- Overview and foundation
- Introduction, review of history
- Fundamentals: definitions, similarity parameters and aeroelastic stability boundaries
- Static aeroelasticity: divergence, lift and control effectiveness, reversal and active suppression
- Introduction to dynamic aeroelasticity: stability vs response, gust response, flutter, buzz
- Stiffness versus strength; response versus stability; static versus dynamic
- Examples of Static aeroelastic behavior

Day Two

- Theory: basic principles of mechanical vibrations
- Modal methods
- Steady and quasi-steady aerodynamics
- Examples of topics related to vibration leading to modal methods

Day Three

- Theory: Unsteady aerodynamics, "Theodorsen" aerodynamics, numerical methods and approximations, strip theory, vortex and doublet lattice panel methods
- Methods of analysis – frequency versus time domain
- Governing equations for the aeroelastic system
- Frequency domain methods: modal formulations, V-g diagrams, k-method (U.S. method) and P-k method (British method)
- Time domain methods
- Examples of Unsteady Aerodynamic solutions

Day Four

- Flutter & Identification of Flutter
- Review of flutter models and solutions
- The flutter boundary: civilian and military requirements, matched point flutter analysis
- Examples of flutter analysis

- Example experiments: ground vibration tests, wind tunnel tests

Day Five

- Aeroelasticity in practice
- Aeroservoelasticity
- Fight test procedures
- Flight test examples
- Nonlinear aeroelasticity—limit cycle oscillations
- Concluding remarks

Classroom hours / CEUs

31.50 classroom hours
3.15 CEUs

Certificate Track

Aircraft Design
Flight Tests and Aircraft Performance

Course Fees

Early registration course fee: $2,595 if you register and pay by the early registration deadline (45 days out).

Regular registration course fee: $2,795 if you register and pay after the early registration deadline.

Course Materials

Course materials, including outlines, presentation copies, and supplementary materials, will be accessible through Canvas, KU's online learning system. Instructions to access Canvas will be provided upon completed registration. Students are required to bring a computer or other electronic device with PDF-viewing capabilities with them to class each day. If you require accommodation contact us at professionalprograms@ku.edu and we will work with you on an accessible solution.

U.S. Federal Employee Discount

This course is available to U.S. federal employees at 10% off the registration fee. To receive the federal employee discount, you must enter the code **FGVT116** during the checkout process. Please note that you must validate your eligibility to receive this discount by entering your U.S. government email address (ending in .gov or .mil) when creating your online registration profile. This discount is available for both the early registration and regular registration fees.

Canada Department of National Defence Discount
This course is available to Canada DND employees at 10% off the registration fee. Please contact the DND Procurement Authority (DAP 2-3) for details. Please note that you cannot register using our online system when requesting this discount. This discount is available for both the early registration and regular registration fees.

Instructor Bio

Thomas M. Hermann has a strong background in aeroelastic analysis of aerospace structures and has performed structural dynamic, aeroelastic, and dynamic loads analysis of aircraft ranging from single engine general aviation aircraft to twin turboprop, carrier based, AEW aircraft to twin turbofan transports and business jets. In the course of these projects, he has also conducted ground vibration and flight flutter testing. He completed his master's thesis in transonic aeroelasticity at the University of Kansas under Dr. C. Edward Lan.

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