AE 255 Aeroelasticity

Aeroelasticity is the study of the interactions between the elastodynamics of a flexible lifting surface with the dynamics of the fluid flow over it. The issues that are of concern in this study include stability of the aeroelastic system, its static and dynamic response, and controlling these aeroelastic instabilities and response.
Aeroelastic or fluid-elastic interactions occurs in myriad problems in nature and engineering. Commonly occurring instances in nature include oro-nasal snoring, blood flow in veins and arteries, swaying of grass, leaves and branches of trees and plants, and flapping propulsion in avian and aquatic animals. In engineering, one encounters aeroelastic problems in offset printing machines when reams or sheets of paper flutters, fluid-elastic instabilities in flexible pipes and channels conveying fluids, fluttering flags, vortex-induced oscillations of bridges, galloping of transmission line cables, and flutter of wind turbine blades.
In aerospace engineering, they have received sustained attention from the beginning of human engineered flight. Typical problems are: aeroservoelasticity of aircraft wings and control surfaces, transonic flutter of aircraft wings and turbomachinery blade cascades, aeroelasticity of rotorcraft blades, and hypersonic vehicle aeroelasticity.

Pre-requisites

Senior undergraduate level or graduate level course in vibration and aerodynamics/fluid dynamics is necessary to credit this course.

Outline

Finite state models of aeroelastic systems; Dynamic aeroelasticity; Aero-servoelasticity; Static aeroelasticity.

Evaluation

5 assignments each having 10% weightage in the overall evaluation; 1 mid-semester exam with 10% weightage; a term paper with 20% weightage; and an end-semester exam having 20% weightage.
All assignments, term paper, mid-sem and end-semester exam will involve numerical work using MATLAB/OCTAVE.

Course Outcomes

After completing this course, the student should be able to understand and identify the nature of aeroelastic problems encountered in flight vehicles, and choose the appropriate methods and tools to estimate and solve specific aeroelastic problems.

Lecture topics

	Topics
1	Overview of aeroelasticity
2	Equations of motion for a flexible wing section model
3	Finite state model of unsteady aerodynamics of flow over a wing section
4	Binary Flutter
5	Ternary and Quaternary Flutter
6	Gust and turbulence impinging on a flexible wing
7	Aeroservoelasticity
8	Torsional wing divergence and lift distribution over a flexible wing
9	Effect of wing flexibility on control effectiveness in roll
10	Flight dynamic equations of a flexible aircraft

References

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