AEROSP-527 Unsteady Flows and Acoustics

3 Credits, Winter 2019, Tue/Thu 2:30-4:00pm, EECS 1303

Instructor:

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Co-Instructor:

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Course Text:

No text book is required. Lecture notes and reading material will be posted on Canvas.

Reference Texts:

1. Principles of Ideal-Fluid Aerodynamics, K. Karamcheti, Krieger Pub, 1980.
2. Sound and Sources of Sound, A. Dowling & Ffowcs-Williams, Ellis Horwood, 1983.
3. Unsteady Combustor Physics, T. Lieuwen, Cambridge University Press, 2012.

Course goals:

1). Learn the fundamental physical principles of inviscid flows and acoustics

2). Develop techniques to predict forces and moments on bodies in motion

3). Gain an in-depth understanding and develop predictive tools for flow-generated sound

4). Learn the mechanisms behind instabilities generated by mutual interactions between pressure waves and heat release in internal flows

5). Gain an appreciation for the state-of-the-art in relevant research.

Pre-requisites:

Undergraduate aerodynamics/fluid mechanics, interest to learn and utilize techniques from mathematical physics (Greens functions, Generalized derivatives, etc.) & computer programming skills.

Course contents:

Fluid Dynamics Review:

Potential flow

Vortex dynamics

Thin airfoil theory

Unsteady Aerodynamics:

Unsteady potential flow

Unsteady thin airfoil theory

Indicial response method for imposed motions and gusts

Fundamentals of Acoustics:

Introduction to physical acoustics

Wave propagation phenomena

Acoustic impedance and admittance

Acoustics in inhomogeneous media

Aeroacoustics:

Sound generation in quiescent media

Sound generation by moving bodies and turbulence (Ffowcs Williams & Hawkings theory)

Thermoacoustics:

Concept of thermoacoustic instability and underlying physical mechanisms

Frequency-domain & time-domain modeling of thermoacoustic instabilities

Acoustic/flame interactions

Applications:

Applications in helicopter flight, flapping wings, wind turbines, etc.

Helicopter/propeller rotor noise

Gas turbine and rocket combustor instabilities

Grading:

Homeworks/Projects : 60 %, Written Mid Term : 20 %, Oral Final Exam : 20 %