A & AE 517: UNSTEADY AERODYNAMICS
PROF. ALINA ALEXEENKO

Day & Time: M, W 4:30 - 5:45 pm **Room:** ARMS 3115

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Hours: Fridays 10 am – 12 noon or by appointment

Recommended Texts:
1.Bisplinghoff, R. L., Ashley, H., Halfman, R. L.: "Aeroelasticity," Addison, 1955.
2.Dowell, E. H. (editor), Curtiss, H.C., Scanlan, R. H., Sisto, F.: "A Modern Course in Aeroelasticity," Sijthoff & Noordhoff, 1978. (Available electronically).
3. Cebeci, M., Platzer, H., Chen, H., Chang, K-C., Shao, J. P., "Analysis of low-speed unsteady airfoil flows", Springer, 2004. (Available electronically).
4. Landahl, M., "Unsteady Transonic Flow", Cambridge, 1989.

Prerequisites: AAE334 or equivalent.

Objectives: Review of inviscid fluid dynamics. Linearized flow theory; indicial and harmonic responses; panel methods for unsteady airfoils and wings. Simple applications to dynamic simulation and aeroelastic stability. Nonlinear theory for transonic flow; introduction to time dependent numerical methods.

Grading:
Homework 40% Midterm 30 % Final Project 30%

Homework

There will be about 8 homework assignments. Some will be paper-and-pencil solution of problems, others will be computer assignments. I recommend using Matlab (available at all computer labs on campus), but you can use any programming language (Java, C, Fortran).

Exam: Midterm exam the week of October 5 - 9. Closed books, open notes.

Course Projects:
Timeline for course projects: project proposal due after October break; progress report due first week of November. Project presentations during the last week of classes. Teams of up to two. Select a problem that is interesting to you and is related to unsteady aerodynamics.

Course Outline

I.Review and Introduction of Basic Concepts: indicial response, harmonic response,, aerodynamic damping, static and quasi-steady approximations, aerodynamic transfer functions.

II.Review of Inviscid Fluid Dynamics
Euler's Equation
1.Material Derivatives
2.Vorticity
3.Potential Flows: Bernoulli's equation; nonlinear wave equation
4.Boundary Conditions

III.Incompressible Potential Flow
1.Classical Hydrodynamics: apparent mass forces
2.Vortex Effects in 2D
3.Linearized Aerodynamics:
- Thin wings
- separation of steady and unsteady effects
- 2D airfoils:
  - indicial response – the Wagner Problem
  - harmonic response – Theodorsen function
  - dynamic system calculations
  - numerical solution methods
- planar wings: unsteady panel methods in 3D

IV.Linearized Compressible Flow
1.The reduced wave equation
2.Planar wings in simple harmonic motion
- subsonic flow: modal method, panel methods
- supersonic flow: Mach box techniques

I.Transonic Flow
1.Transonic non-linearities: small disturbance equation
2.Shock waves
3.Numerical solution methods