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:

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