Overview

1. Introduction

- Brief History
- Flow statics
- Coefficients of lift, drag, pitching moment
- Dimensional Analysis (Buckingham's Π theorem)
- Similarity - Mach number, Reynolds number
- Vorticity
- Circulation
- Stream function
- Velocity potential
- Pressure coefficient
- Center of pressure
- Cp vs. x/c curve

2. Basic Equations

- Continuity equation
- Momentum equations
- Energy equation
- Material (Substantial) derivative
- Hydrostatic equation
- Bernoulli's equation

3. Inviscid, incompressible flow

- Laplace's equation (+ irrotational)
- Potential flow: uniform, source, doublet, vortex (2D &3D)
- Combination of potentials
  uniform+doublet --> nonlifting cylinder or sphere
  uniform+doublet+vortex in 2-D--> lifting cylinder
- Kutta-Joukowski theorem
- Source Panel method

4. Incompressible (& inviscid) flow over airfoils

-Airfoil nomenclature: chord, camber,thickness, leading-edge, trailing -edge , etc.
- Cl vs. α curve : lift slope, stall (separation), zero-lift AOA, AC

- Vortex filament, vortex sheet
- Kutta condition
- Kelvin's circulation theorem: starting vortex, stopping vortex
- Thin airfoil theory : symmetrical airfoil, cambered airfoil
- Vortex Panel Method
- Real case: deep stall, light stall, leading & trailing edge flap, multi-element airfoils, flaperon, drooped leading-edge, etc.

5. Incompressible (& inviscid) flow over wings

- finite & infinite wing
- horseshoe vortex system: bound vortex, trailing vortices, downwash
- Induced drag, induced angle of attack, effective angle of attack
- D'Alembert's paradox
- Drag in incompressible flow = induced drag + profile drag
- Vortex filament, Biot-Savart law, Helmholtz's theorem
- Prandtl's lifting line theory
- Elliptic lift distribution: constant downwash, minimum induced drag,
- General lift distribution: Oswald's (span efficiency) factor
- Effect of aspect ratio
- Vortex lattice method

6. Other topics

- Methods of image
- Boundary layer & Separation
- Equations and their assumptions in fluid mechanics
  - Navier-Stokes equation
  - Euler equation
  - Full potential equation
  - Transonic Small Disturbance equation
  - Laplace equation