## ME421. Foundations of Aerodynamics.

**Victor Yakhot**

## Syllabus. Spring 2013 .

**1/17, 22.** Fluids; continuum description; Elements of kinetic theory; derivation of viscosity and pressure.
**1/24.** Kinematics; acceleration; streamlines/pathlines; fluxes; vorticity. **HW1.**
**1/29, 31.** Conservation laws; continuity, Euler and Navier-Stokes equations; Euler equation; Boundary conditions; vorticity; vortex force; Kelvin's theorem; Incompressible fluids; **HW2.**
**2/5-26.** Potential flows; 2D examples: uniform flow; sinks and sources; vortex; doublets and multi-pole expansion; Flow past cylinder; Joukovskii theorem. Drag and lift; Joukovskii theorem; Accelerating cylinder and cylinder + vortex: Panel method; Aerofoils; Wings; Lift; Drag; **HW 3-4.**

**3/5** Review.

## 3/7. Midterm.

**03/19 , 21.** vortex sheets; forces; flow over plate; thin airfoil theory; flow past 2d airfoil; Lift; **HW 5**;

**3/26, 28.**. symmetric airfoil; cambered airfoils; **HW5**; X-foil code; **Numerical Project.**

**4/2, 4.** Flow over finite wings; downwash and induced drag; vortex filament; Prandtl theory: elliptic lift distribution; aspect ratio **HW6.**;

## Viscous effects.

**4/9-23.** - The Navier Stokes equations; Reynolds number; Laminar- Couette, channel and pipe flows. Flow separation; Friction and drag coefficients; **HW 7-8.** Prandtl laminar boundary layer theory; Turbulence; channel/pipe flows. Turbulent boundary layers ; Viscous effects on wings. **HW9.**

**Industrial CFD (Invited Lecture)**. **HW 6-8.**

**4/30**. Review; discussion;

## Two labs. The dates to be determined. Numerical project.
## Books.

**1. D. Wilcox, "Basic Fluid Mechanics".**

**2. J. Anderson, Fundamentals of aerodynamics.**

**3. V.Yakhot,, ME421. Fluid Mechanics and aerodynamics. My lecture notes.**

**4. I. Abbott and A. Doenhoff, Theory of wing sections, Dover Publications, NY 1958.**