ME421. Foundations of Aerodynamics.

Victor Yakhot

Syllabus. Spring 2015 .

1/20, 27. Fluids; continuum description; Elements of kinetic theory; derivation of viscosity and pressure.
1/22. Kinematics; acceleration; streamlines/pathlines; fluxes; vorticity. **HW1.**
1/27, 30. Conservation laws; continuity, Euler and Navier-Stokes equations; Euler equation; Boundary conditions; vorticity; vortex force; Kelvin's theorem; Incompressible fluids; **HW2.**
2/3-26. 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.**

3/3 Review.

3/5. Midterm.

03/17 , 19. vortex sheets; forces; flow over plate; thin airfoil theory; flow past 2d airfoil; Lift; **HW 5**;

3/24, 26.. symmetric airfoil; cambered airfoils; **HW5**; X-foil code; **Numerical Project.**

4/2, 7. Flow over finite wings; downwash and induced drag; vortex filament; Prandtl theory: elliptic lift distribution; aspect ratio **HW6.**;

Viscous effects.

4/9-21. - 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.**

4/23; Industrial CFD (Invited Lecture). **HW 6-8.**

4/28. Review; discussion;

Two labs. The dates to be determined. Numerical project. (TBD) May, Final Exam.

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.