ME422. Fluid II

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Syllabus. Spring 2012 .

In this course classical advanced fluid mechanics will be taught together with the most modern developments in kinetic representations, nanofluidics , basic aerodynamics and elements of turbulence theory.

Fluids; continuum description; Elements of kinetic theory; derivation of viscosity and pressure.

Kinematics; acceleration; streamlines/pathlines; fluxes; vorticity.

Conservation laws; continuity, Euler and Navier-Stokes equations; Euler equation; Boundary conditions; vorticity; vortex force;

Kelvin's theorem; Incompressible fluids; 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; Induced Drag. Wind energy

Gravity waves; Rotating fluids; Sound;

Viscous effects.

04/26-5/3. - The Navier Stokes equations; Reynolds number; Laminar- Couette, channel and pipe flows. Flow separation; Friction and drag coefficients; Prandtl laminar boundary layer theory; Turbulence; channel/pipe flows. Turbulent boundary layers ; Viscous effects on wings.

Modern Developments.

Elements of nanofluidics; Kinetic theory; Oscillating flows; Atomic Force Microscopy. Modern experiments;

Two-three 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 ad aerodynamics. My lecture notes.

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

1958.