MECH_ENG 425 Fundamentals of Fluid Dynamics
Fall 2019

Class hours: MW 9:30 AM – 10:50 AM   **Room**: Annenberg G01

Instructor: Neelesh A. Patankar, Room Tech. L490, 847-491-3021, n-patankar@northwestern.edu.

Text: *Fluid Mechanics*, 5th Edition or later; Kundu, Cohen, & Dowling; Academic Press, 2011 or later.

Course prerequisites: Background of undergraduate fluid mechanics, partial differential equations and thermodynamics.

Course syllabus

- **Introduction (Ch. 1):** Historical remarks, properties of fluids and the continuum hypothesis, classical thermodynamics, dimensional analysis.

- **Vector calculus (Ch. 2):** Symbolic or Gibbs notation and index notation, tensors and tensor operations, integral formulas.

- **Kinematics (Ch. 3):** Lagrangian and Eulerian descriptions, stream, path and streak lines, deformation and deformations-rate tensors, vorticity and circulation.

- **Conservation laws (Ch. 4):** Conservation of mass, momentum and energy, introduction to Newtonian and non-Newtonian rheologies, derivation of Navier-Stokes equation.

- **Analytic solutions (Ch. 8):** Pressure driven (Poiseuille) flows, plane and circular Couette flows, double falling film, impulsively started plate (Stokes' first problem, the Rayleigh problem), oscillating plate (Stokes' second problem), diffusion of vortex sheet, decay of line vortex (Oseen vortex).

- **Topics menu (topic selection will be based on students' preference):** Ideal flows (Ch. 6), boundary layer flows (Ch. 9), instabilities (Ch. 11), fluid physics of sustainability, fluid dynamics of cardiovascular, lung, and gastrointestinal systems, introduction to machine learning for fluid dynamics.

Grading: Homework ("every" Wednesday)   **30%**
          Three take-home exams (1 week duration)   **70%**
          1. Oct. 9 – Oct. 16, 2019: **20%**
          2. Nov. 6 – Nov. 13, 2019: **20%**
          3. Dec. 4 – Dec. 11, 2019: **30%**