ES 607 - Foundations of Fluid Dynamics

Instructor: Dilip Sundaram

E-mail: dilip.sundaram@iitgn.ac.in

Lecture and Tutorial room: 7/205

Lecture hours: Tuesday (1:05-2:00 PM), Thursday and Friday (02:05 PM-3:00 PM)

Tutorial hours: Monday (02:05 PM-3:00 PM)

Office: 6/356

Teaching Assistants: Aditya Sakhare and Shubham Chouksey

General description

This is a postgraduate level course on fluid dynamics. The course will provide a comprehensive understanding of various topics of interest to fluid dynamics including fluid kinematics, conservation laws, vorticity dynamics, potential flows, Laminar flow solutions, Laminar boundary layers, and brief overview of instability and turbulence.

Course contents

Introduction to fluid dynamics, importance, applications, classification; Fluid properties; Tensor notation; Kinematics, Lagrangian vs Eulerian description, Material derivative, streamlines, stress and strain, vorticity, circulation, stream function, flow patterns and visualization; Conservation laws, control volume analysis, Reynolds transport theorem, differential equations for conservation of mass, momentum, and energy, stress tensor, constitutive equations; Bernoulli's equation; Buoyancy; Vorticity equation, Kelvin's circulation theorems, vorticity equation; Irrotational flow, complex variables, elementary flows, superposition, images, conformal mapping; Laminar flow solutions, flow patterns, exact solutions, similarity solutions, numerical analysis; Laminar boundary layers, boundary layer approximation, flat plate boundary layer, Falkner-Skan flows; Flow separation; Flow over cylinders and spheres; Free shear flows; Brief overview of instability and turbulence

Learning objectives

Upon successfully completing the course, the student should be able to:

1. demonstrate a graduate level understanding of key concepts in fluid dynamics

2. deal with complex set of equations and math and understand the physical significance

3. independently derive, understand, and apply conservation equations to fluid mechanics problems and solve them

4. handle equations and manipulate them in tensor form

5. use common computer programs/softwares to solve fluid mechanics problems

Texts and references

P.K. Kundu, I.M. Cohen, *Fluid Mechanics*, Academic Press, Third edition.

F. White, *Viscous Fluid Flow*, Third edition, McGraw Hill, India edition 2011.

G.K. Batchelor, *An Introduction to Fluid Dynamics*, Cambridge University Press, Indian edition.

H.T. Schlichting, *Boundary layer theory*, Springer.

Y.A. Cengel, J.M. Cimbala, *Fluid Mechanics: Fundamentals and Applications*, McGraw Hill, Special India edition, 2014.

Prerequisites

Undergraduate level understanding of thermodynamics, fluid mechanics, and heat transfer