ROMA FLME 204: Fluid Mechanics

Instructor
Prof. Roberto Camussi

Credits
4

Textbook
Main textbooks:
- Reader and notes provided by professor

Further Reading

Objectives
To help students explain the critical properties of a fluid, be able to apply Newton’s Laws of Motion, Conservation of Mass, and Conservation of Energy (1st Law of Thermodynamics) to fluid mechanics, and to develop and understanding of how each term of important fluid mechanics equations relates to these foundational laws. Students will be able to classify problems into basics types and, use control volume analysis to solve them including (e.g., inviscid/viscous, internal/external, incompressible/compressible flows. During this course, the students will be able to manage both the general equations and their simplified forms written both in dimensional and dimensionless form. Learn to use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity.

Topics
- Introductory Concepts: definitions, dimensions and units, properties of fluids, velocity field, thermodynamic, viscosity etc., Newtonian/Non-Newtonian Fluids, derivation of governing equations, boundary conditions, Kinematics.
• Hydrostatics and Buoyancy: Manometry, hydrostatic forces & pressure gradient, buoyancy and stability, forces over submerged surfaces
• Integral and Control Volumes: basic physical laws of fluid mechanics, Reynolds Transport Theorem, conservation of Mass, Energy and Momentum – momentum, energy and Bernoulli equations
• Flow Regimes & Boundary Layers – Prandtl equations; similarity solutions (Blasius equation); integral methods.
• Dimensional Analysis and Similarity – Principle of dimensional homogeneity, Buckingham PI Theorem, nondimensionalization of the basic equations, modelling.
• Potential Flows: superposition of simple solutions; examples (fixed cylinder and rotating cylinder); generation of Lift and the Kutta-Joukowsky theorem.
• Turbomachinery: introduction and classification, the Centrifugal pump, suction lift and the concept of net positive suction head, pump performance curves and similarity rules, sizing pumps to system characteristics
• Compressible Flow: isoentropic flows with area change, the normal shock wave
• Viscous Flow in Ducts: Reynolds-number regimes & turbulence, drag forces, terminal velocity and drag coefficients, flow in circular pipes
• Mixing: Reynolds number, power numbers and scale up
• Introduction to Transport Phenomena: mechanisms of transport phenomena, introduction to transport theorems

Assessment

40% mid-term exam
20% projects
40% final exam