

MCL106 FLUID MECHANICS
(for Mechanical Engineers)
(3-1-0)

Course objectives:

The objective of this course is to introduce concepts of fluid statics and dynamics through conservation laws. The academic objective is to teach and bring out the role of fluid flows in real-life Mechanical engineering problems. Integral as well as differential flow analysis will be covered with an emphasis on the fundamental concepts.

Syllabus

Introduction: scope of fluid mechanics in real life and mechanical engineering, methods of analysis (system vs. volume), Fluid as a continuum, Eulerian/Lagrangian description, Newton's law of viscosity.

Fluid Statics: Hydrostatic force on submerged surfaces, Buoyancy and stability, Fluids in rigid-body motion.

Flow kinematics: Pathlines, streaklines and streamlines, vorticity and circulation.

Classification: Internal vs External, incompressible vs compressible, laminar vs turbulent flows

Integral flow analysis: Reynolds transport theorem, conservation of mass, linear and angular momentum for inertial and accelerating control volumes, conservation of energy, Bernoulli's equation.

Differential analysis of fluid motion: Conservation of mass, stream function for 2D incompressible flow, fluid translation, rotation and deformation, conservation of momentum, Navier-Stokes equations, incompressible inviscid flows, potential flow.

Dimensional analysis and similitude: Dimensionless groups, scaling, non-dimensionalization.

Viscous flows: fully developed laminar and turbulent pipe flows, head loss, boundary layer concept, flow separation, comparison of laminar and turbulent velocity profiles, streamlining and implications.

Compressible flow: speed of sound, the Mach cone, stagnation properties, critical conditions, isentropic flows and converging-diverging nozzles.

Textbooks and References:

1. Fluid Mechanics by F.M. White, Tata McGraw Hill, 7th edition, 2011.
http://ftp.demec.ufpr.br/disciplinas/TM240/Marchi/Bibliografia/White_2011_7ed_Fluid-Mechanics.pdf
2. Fluid Mechanics by R.W. Fox and A.T. McDonald, Wiley, 10th edition, 2021.
http://ftp.demec.ufpr.br/disciplinas/TM240/Marchi/Bibliografia/Pritchard-Fox-McDonalds_2011_8ed_Fluid-Mechanics.pdf
3. Fluid Mechanics by P. K. Kundu, I. M. Cohen and D. R. Dowling, Academic Press and Elsevier, 2012
https://www.academia.edu/20021282/Fluid_Mechanics_4E_Kundu_and_Cohen