

FLUID DYNAMICS

Parallel viscous flow

Plane Couette flow, dynamics viscosity. Momentum equation and boundary conditions. Steady flows including Poiseuille flow in a channel. Unsteady flows, kinematics viscosity, brief description of viscous boundary layers (skin depth).

Kinematics

Material time derivatives. Conservation of mass and the kinematics boundary condition. Incompressibility; Streamfunction for two-dimensional flow. Streamlines and path lines.

Dynamics

Statement of Navier-Stokes momentum equation. Reynolds number, stagnation-point flow; discussion of viscous boundary layer and pressure field. Conservation of momentum; Euler momentum equation. Bernoulli's equation.

Vorticity, vorticity equation, vortex line sketching, irrotational flow remains irrotational.

Potential flow

Velocity potential; Laplace's equation, examples of solutions in spherical and cylindrical geometry by separation of variables. Translating Sphere. Lift on a cylinder with circulation.

Expression for pressure in time-dependent potential flow with potential forces. Oscillations manometer and of a bubble.

Geophysical flows

Linear water waves: dispersion relation, deep and shallow water, standing waves in a container, Rayleigh-Taylor instability.

Euler equations in a rotating frame. Steady geostrophic flow, pressure as streamfunction. Motion in a shallow layer, hydrostatic assumption, modified continuity equation. Conservation of potential vorticity, Rossby radius of deformation.

Appropriate books

- D. J. Acheson Elementary Fluid dynamics Oxford University press 1990
- G. K. Batchelor An Introduction to Fluid dynamics CUP 2000
- G. M. Homsey et al. Multi-Media Fluid Mechanics CUP 2008
- M. van Dyke An Album of Fluid motion Parabolic Press
- M. G. Worster Understanding Fluid Flow CUP 2009