

## Physics of Fluids

### I - What is a fluid ?

- I.1 - Molecular nature
- I.2 - Simple vs complex

### II - How to describe its motion ?

- II.1 - Molecular dynamics
- II.2 - Continuous mechanics

### III - Which equations to solve to predict the flow of simple fluids ?

- III.1 - Newton's equations for continuous media
- III.2 - Navier's closure relation
- III.3 - Navier-Stokes' equation
- III.4 - Equilibrium and the equation of hydrostatics
- III.5 - Perturbation of the equilibrium and acoustics
- III.6 - Measurement of the two viscosities.
- III.7 - Similitude

### IV - Low Reynolds number flows

- IV.1 - Stokes' equations
- IV.2 - Unicity and reversibility
- IV.3 - Swimming at low Reynolds number
- IV.4 - Theory of Lubrication and the equation of Reynolds
- IV.5 - Hele-Shaw flows as potential flows !

### V - High Reynolds number flows (part 1: How do wings work ?)

- V.1 - Euler's equation
- V.2 - Conservation of the circulation - Kelvin's theorem
- V.3 - Persistence of the irrotational character - Helmholtz's theorem
- V.4 - Potential flows
- V.5 - The Rayleigh-Plesset bubble
- V.5 - 2D potential flows and the complex potential
- V.6 - Magnus effect and the d'Alembert's paradox
- V.7 - How to solve the d'Alembert's paradox: boundary layers
- V.8 - Slender bodies vs bluff bodies
- V.9 - The physical origin of vortices
- V.10 - Skin drag and pressure drag
- V.11 - The beauty of wings
- V.12 - Tartaglia vs parabola : the impact on the size of sports' fields

### VI - High Reynolds number flows (part 2: vortices)

- VI.1 - Analogy between Euler's equations and electromagnetism
- VI.2 - Biot-Savart's law for vortices
- VI.3 - Structure of a vortex filament
- VI.4 - Vortex ring dynamics
- VI.5 - Tip vortices and induced drag: the optimal flight
- VI.6 - Kelvin-Helmholtz instability
- VI.7 - Physics of knuckleballs
- VI.8 - Turbulence as a gas of vortices

## VII - High Reynolds number flows (part 3: waves)

VII.1 - The dispersion relation for water waves

VII.2 - Refraction of water waves

VII.3 - Shoaling

VII.4 - Physics of surfing and wave riding

VII.5 - Solitons

## VIII Liquid surfaces

VIII.1 – First basic introduction

VIII.2 – Statistical approach : Cahn-Hilliard-de Gennes

VIII.3 – Wetting

## VIII Liquid surfaces and long range forces

VIII.1 – Van der Waals forces and disjoining pressure

VIII.2 – Thin films stability

VIII.2 – Disjoining pressure measurement

VIII.3 – Wetting and precursor films

## VIII Charged interfaces

VIII.1 Charged interfaces at equilibrium – Poisson Boltzmann & DLVO

VIII.2 Electrokinetic effects

## IX Liquid entrainment

## X Imperfec wetting