# *INSTABILITÉ DES ÉCOULEMENTS ET INTRODUCTION À LA TURBULENCE*

# STABILTY OF FLOW AND INTRODUCTION TO TURBULENCE

**Lecturers:** Christophe BAILLY, Andrea MAFFIOLI

| Lecturers : 20.0 | TC : 16.0 | PW : 0.0 | Autonomy : 12.0 | Study : 0.0 | Project : 0.0 | Language : FR

## Objectives

The turbulent state is encountered in industrial processes, in the atmosphere and the ocean for geophysical flows, as well as in biological fluids, to mention only a few examples. The first objective of this course is to present the analytical tools to characterize stability of flow, by considering small perturbations around a basic flow. The second part is an introduction to turbulence for free shear flows such as mixing layers, jets and wakes (intermittency, entrainment, fully developed flow).

Keywords : Laminar flow, linear stability, inviscid (Rayleigh) and viscous (Orr-Sommerfeld) approaches, turbulent signals, intermittency, entrainment, free shear flows

## Programme

General introduction - Stability of flows - basic notions and tools. Local and global instabilities. Instability thresholds and dimensionless parameters. Linearization. Parallel plane flows. Orr-Somerfeld equation. Non-viscous instabilities: Rayleigh equation. Piecewise linear profiles. Monotonic profiles and neutral modes. Effects of weak nonlinearities. - Turbulent flows - transition to turbulence, analysis of turbulent flow signals, general equations of turbulent flows; turbulent flows with free edges: intermittency, entrainment, identification of turbulent structures

## Learning outcomes

- Master the concepts of linear stability analysis of flows
- Know how to characterize turbulent signals
- Be more familiar with the phenomenology of turbulent flows
- Know how to physically exploit the results of a stability analysis

## Independent study

Objectifs : The work to be done independently allows the course to be illustrated by case studies, and to deepen certain aspects of the course.

Méhodes : Analytical solution of elementary cases for flow stability
Solving the Rayleigh equation on computer for the mixing layer
Analysis of measured turbulent signals (statistics, intermittency)

## Core texts

GODRÈCHE C., MANNEVILLE P., *HYDRODYNAMIC AND NON LINEAR INSTABILITIES*, Cambridge University Press, 1998
SCHMID, P.J., HENNIGSON, D.S. *STABILITY AND TRANSITION IN SHEAR FLOWS*, Springer, 2001
BAILLY, C., COMTE-BELLOT, G.*TURBULENCE*, Springer, 2015

## Assessment

Final mark = 50% Knowledge + 50% Know-how
Knowledge mark = 50% final exam + 50% continuous assessment
Know-how mark = 50% final exam + 50% continuous assessment