PHYSIQUE DES ÉCOULEMENTS TURBULENTS

PHYSICS OF TURBULENT FLOWS

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| Lecturers : 16.0 | TC : 0.0 | PW : 8.0 | Autonomy : 0.0 | Study : 4.0 | Project : 0.0 | Language : AN

Objectives

The course introduces different aspects of the physics of turbulent flows and associated modeling, and illustrates in a practical way some recent results from experimental and numerical studies. The main objectives are to master the basic concepts (generation/development of turbulence, turbulence boundary layer, local equilibrium, non-local role of vorticity, homogeneous and isotropic turbulence, Kolmogorov theory), to develop skills in turbulence modelling and in the analysis of results, as well as to provide an overview of experimental approaches.

Keywords : Turbulence, Reynolds number, turbulent boundary layer, vorticity dynamics, energy transfers, homogeneous and isotropic turbulence, Kolmogorov's theory

Programme

1. Some general properties of turbulence, turbulent structure in spectral space, scales, time average and ergodicity; 2. Mean flow field: Reynolds decomposition, kinetic energy budget, closure by turbulent viscosity, examples and consequences; 3. Wall-bounded turbulent flows: log-law, closure models, phenomenology; 4 - Vorticity:definition, Biot & Savart, deformation, Helmholtz Eq., rapid distorsion theory, vortex pairing, enstrophy, helicicity; 5. Homogeneous and isotropic turbulence: two-point velocity correlation tensor, length scales, spectral tensor, isotropic, 1-D spectra, Taylor's assumption, energy spectrum, isotropic turbulence, Karman & Howarth relation, experiments, Kolmogorov's theory, Lin's eq.; 6. Flow field survey and visualization

Learning outcomes

- Know the spatio-temporal description of turbulence
- Be able to describe and model some classical turbulent flows
- Know how to interpret the behavior of turbulent flows

Independent study

Objectifs : Exercises are regularly proposed (two homework assignments freely chosen in a list, involving signal processing or the development of simple models using Matlab/Python among others), ...

Méhodes : ..., two lab work (TP) are also proposed (numerical simulation of channel flow and hot wire anemometer measurements in a turbulent round jet) as well as a final small class (BE).

Core texts

Bailly, C. & Comte-Bellot, G., *TURBULENCE (IN ENGLISH)*, Springer, ISBN 978-3-319-16159-4, 2015
Davidson, P. A. *TURBULENCE*, Oxford University Press, Oxford, 2004
Pope, S.B.*TURBULENT FLOWS*, Cambridge University Press, Cambridge, 2000

Assessment

Final mark = 50% Knowledge + 50% Know-how
Knowledge = 80% homework assignements + 20% lab work
Know-how = 40% homework assignements + 60% lab work