Unit information

Program	Mechanical Science (53001010053P0)
Course unit	Turbulence
Unit code	PCMEC4000
Unit number	4000
Credit points	4
Period	-
Professor	Taygoara Felamingo de Oliveira
Prerequisites	

Unit outline

Objective:

Provide the student with solid knowledge about the characteristics of turbulent flows as a physical phenomenon, understanding of classical theories about turbulence in fluids and, above all, with safe notions of modeling turbulent flows, allowing students to develop a critical view on results of simulations and laboratory experiments involving turbulent flows, in addition to being able to correctly select turbulence models that are most suitable for each application.

Purpose:

This is an advanced course in Fluid Mechanics that allows students to have close contact with one of the most relevant research topics in Fluid Mechanics, in addition to providing the necessary elements to use turbulence models competently, whether when making use of numerical simulation packages of turbulent flows, as when developing your own simulation tools.

Contents:

The nature of turbulent flows: experiments by Taylor, Bernard and Reynolds, turbulence as a multiscale phenomenon, the closure problem. **Equations of motion:** Navier-Stokes equations, energy equation and elements of vorticity dynamics. **Origins of turbulence:** turbulence as a chaotic phenomenon, elementary properties of free turbulent flows (turbulence development, rate of dissipation of turbulence kinetic energy, memory, need for statistical approach). **Theories for turbulent flows:** Richardson theories (time and length scales), Kolmogorov (small scale dynamics), turbulent diffusion **Turbulence models:** Reynolds decomposition, spatial and temporal correlations, mean Reynolds equations and the Reynolds tensor, Boussinesq hypothesis and the concept of turbulent viscosity. Algebraic (mixing length) and half-equation models. Kinetic energy transport models of turbulence, one- and two-equation models, including k-\omega, k-\epsilon, and SST, models for the Reynolds stress tensor.

Assessment

Homeworks, guided self-studies; Exams, and seminars

Obs:

Reference:	1. W. Kollmann, Navier-Stokes Turbulence: Theory and Analysis, Springer, 2020. 2. D.C. Wilcox, Turbulence Modeling for CFD, DCW, 1994. 3. P. A. Davidson, TURBULENCE An Introduction for Scientists and Engineers, Oxford Universty Press, 2015. 4. Tennekes, H., & Lumley, J.L. A fisrt course in turbulence. MIT Press, 1987. 5. Batchelor, G.K. The theory of homogeneous turbulence, Cambridge, 1953.