



Environment fluid mechanics and hydraulics Part II

Prof. Oreste Fecarotta

Credits: 3 CFU

Number of hours: 24 frontal hours

Data: 11 November - 4 December 2025

Objectives:

The course will provide the basis for the numerical modelling of turbulent fluid flows

Course programme:

Different themes will be approached through a set of invited lectures and exercises that deal with:

- Laminar flow in a channel and Poiseuille profile
- RANS equations and Boussinesq eddy viscosity
- Zero equations models for turbulent channel flows: mixing length, Van Driest damping formula and Prantl log-law.
- Two equations models: $k-\epsilon$, $k-\omega$ and SST $k-\omega$ models
- Finite volume method
- Basic OpenFoam applications: simulation of a channel flow in turbulent conditions
- Introduction to Large Eddy Simulations and statistics of the turbulent flow

Assessment methods: Final interview

Contact for information:

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Lectures Program

N	Date	Schedule	Duration	Teacher	Topic
1	11/11/25	9:30- 12:30	3 hours	Fecarotta	Laminar velocity profile in a plane channel flow: Newton law, viscous shear stress, integration of the velocity profile and laminar resistance formula. Reynolds number and resistance index. Application: use of MS Excel for the calculation of the profile and numerical

					integration for the calculation of the flow rate.
2	13/11/25	13:30-16:30	3 hours	Fecarotta	Prandtl turbulent velocity profile in a plane channel flow: mixing length and its physical meaning, total shear stress, viscous shear stress, turbulent (Reynolds) shear stress, modelling of the Reynolds stress, Boussinesq turbulent viscosity, viscous sub-layer, log law
3	18/11/25	9:30-12:30	3 hours	Fecarotta	Numerical integration of a zero equation model for the modelling of the Boussinesq turbulent viscosity. Van Driest damping formula.
4	20/11/25	13:30-16:30	3 hours	Fecarotta	Finite volume method and discretization of the Navier-Stokes equations. Introduction to OpenFoam: file managing and dictionary syntax.
5	25/12/25	9:30-12:30	3 hours	Fecarotta	OpenFoam file managing and settings for a first CFD simulation. Description of the k-epsilon model
6	27/12/25	13:30-16:30	3 hours	Fecarotta	Calculation of a fluid dynamic mesh for the k-epsilon model. Description of the k-omega, BST k-omega and SST k-omega models. Calculation of a fluid dynamic mesh for a k-omega model. OpenFoam CFD simulation of a plan channel flow with $Re=50'000$ with k-epsilon and SST k-omega
7	2/12/25	9:30-12:30	3 hours	Fecarotta	Analysis and elaboration of the OpenFoam results of the k-epsilon and k-omega simulations and their comparisons. Description of the LES model. PISO Algorithm. Calculation of a fluid dynamic mesh for a LES simulation with $Re_{\tau}=180$.
8	4/12/25	13:30-16:30	3 hours	Fecarotta	Elaboration of the LES results for a plane channel flow with $Re_{\tau}=180$. Elaboration of the fluid dynamic fields. Statistics of the turbulent flow: mean, standard deviation, skewness and flatness.