Learning Objectives

- Fluid dynamic framework:
    - Understand mass and momentum conservation equations
    - Vortex flow: Velocity and pressure fields (Free vortex, Rankine model)
    - Boundary layer: Describe the different states of a boundary layer

- Basic flows:
    - Understand and express head losses (regular and singular) in a hydraulic system
        - Know how to use Moody diagram for circular pipes
    - Poiseuille flow: Hypothesis – Analytical solution of the velocity field
    - Flow around a profiled body:
        - Define the pressure, lift and drag coefficients
        - Draw typical pressure evolution on suction and pressure sides
        - Draw typical Lift and Drag coefficients vs incidence angle

- Energy conservation:
    - Bernoulli equation along a streamline:
        - Application in simple cases (e.g. Siphon, Venturi, Toricelli flows, …)
        - The case of a flow around a profiled body
    - Understand the specific energy balance in hydraulic turbines and pumps

- Types of hydraulic turbines:
    - Explain the difference between action and reaction turbines
    - Name the most common types of hydraulic turbines and describe the role of their main components
    - Understand the meaning of the specific speed

- Cavitation in hydraulic machines:
    - Define the cavitation phenomenon: Incipience, types, effects, …
    - Express the condition of cavitation occurrence in a flowing liquid in dimensional and non-dimensional ways
    - Describe the collapse of a spherical bubble in an infinite liquid volume and explain the erosion mechanism

- Similarity rules for turbomachines:

- o Draw the velocity triangle and explain its role in flow similarity
- o Euler equation: Understand its meaning
- o Describe the benefits and limitations of model tests
- o Understand the role of Reynolds, Froude and Thoma numbers
- o Be able to formulate and evaluate these numbers in a specific case

- Pelton turbines:

  - o Derive the force due to an impinging jet on a curved surface
  - o Explain the main causes of erosion in Pelton turbines

- Centrifugal pumps:

  - o Describe the working principle and the role of main components
  - o Differentiate between radial, mixed and axial pumps
  - o Understand the Euler equation in the case of centrifugal pumps
  - o Use non-dimensional parameters to predict the performance of a pump, using model test data