Semester Projects, Spring 2025

We present hereafter a non-exhaustive list of possible projects related to experimental fluid dynamics, which may be suited for semester or master projects.

If you have any other project idea, do not hesitate to propose it. We can then discuss about its relevance and verify if it fits to our objectives and infrastructure.

1. Effect of trailing edge shape on Karman vortex dynamics

Supervisor: M. Farhat, Th. Berger

Description: We propose to investigate how the shape of a hydrofoil trailing edge may influence the shedding process of Karman vortices and related vibration. To this end, we will use a 2D NACA hydrofoil with different trailing edge shapes and measure the vortex induced vibration for a wide range of flow velocity. We will use 3D printing to manufacture various inserts, which we will attach to the hydrofoil to modify its trailing edge. The test will be conducted in the High-Speed Cavitation Tunnel with relevant instrumentation. The ultimate goal is to converge towards the optimum design of the trailing edge, which minimizes the vortex induced vibration.

2. Effect of gas content on cavitation incipience and development

Supervisor: M. Farhat

Description: The role of gas content on cavitation is still not fully understood. We propose in the actual project to investigate this issue in the High-Speed Cavitation Tunnel. To this end, we will use a 2D Naca hydrofoil and observe the incipience of cavitation as well as its development for different flow conditions. A special focus will be put on the transition from sheet to cloud cavitation. The tests will be carried out for different gas content, which will be monitored using an oxygen probe. Besides, we will also vary the flow velocity to examine the role of Reynolds number on cavitation development.

3. Orbital sloshing dynamics – Effects of viscosity

Supervisor: M. Farhat

Description: Orbital sloshing is widely used to mix and oxygenate bioreactors for cell cultivation. Here, we intend to investigate the role of viscosity on the sloshing dynamics. To this end, we will use water mixed with glycerol to vary the viscosity in a wide range. The resulting sloshing dynamics will be analyzed (mode shapes, amplitudes, frequency, …) and systematically compared with the baseline case made of water at similar shaking conditions.

4. Orbital sloshing dynamics of non-Newtonian fluids

Supervisor: M. Farhat

Description: Orbital sloshing is widely used to mix and oxygenate bioreactors for cell cultivation. Here, we intend to investigate the sloshing dynamics of a non-Newtonian fluid and compare it with water. We will use Xanthan gum to prepare a shear thinning fluid, which we will characterize with the help of a rheometer. We will then observe the shape and dynamics of the free surface for different values of eccentricity and rotation speed. The results will be compared with the baseline case made of water at similar shaking conditions.

5. Generation of a pulsatile flow without moving parts

Supervisor: M. Farhat, A. Sache

Description: We use pulsatile pump to generate a flow that mimics the blood flow in arteries. We propose in the present project to build a smart device that generates pulsatile flow without the need of a pulsatile pump or any other moving parts. To this end, we will start from a venturi-like tube, made of flexible gel and adapt it to produce a fluctuating flow rate in a closed circuit at a specific frequency.

N.B.: Besides fluid mechanics, this project requires skills in material science and manufacturing of silicon models.

6. Cavitation bubbles near an elastic wall: Effect of static pressure

Supervisor: M. Farhat, A. Sache

Description: The dynamics of a cavitation bubble near a rigid wall is fully characterized by the stand-off parameter (gamma) regardless of the static pressure of the surrounding fluid. When a cavitation bubble evolves near an elastic wall, the ratio of its elastic moduli over the static pressure is believed to be an important similarity parameter. The goal of the present project is to verify experimentally this assumption by quantifying the effects of both the static pressure and wall elasticity on the dynamics of a cavitation bubble near an elastic wall. Varying these two parameters, the experiments will enable to find similarities between different cases. To do so, we propose to use our existing experimental setup to generate a single laser-induced cavitation bubble. Elastic boundaries, made of hydrogels with varying elastic moduli, will be prepared and placed at variable distance from the bubble center. The pressure in the water tank will be varied from 1 atm down to ~0.2 atm. High-speed imaging will be conducted to retrieve the evolution of the bubble size with time. The results will be compared with the baseline case study made of rigid wall. Besides, our in-house boundary element code may be used for further investigations.

7. Development of a pressure-based device for water leakage detection

Supervisor: M. Farhat

Description: Climate change, droughts, water shortages and population growth are increasing the pressure on existing water resources. Therefore, there is a strong need to improve water management through a reduction of water leakage, which exceeds 20% of the water in the supply system for many countries.

We propose to investigate the possibility to monitor the water leakage through pressure measurements. We argue that any loss of water in a network generates a measurable change of the pressure at a given location. We propose to monitor the pressure using an Arduino-based device and a pressure sensor.

Remark: This project may be suited for a group of 2 students