

## Assignment 01: Reynolds Number and Flow Regime Analysis

**Due Date:** Wed 22<sup>nd</sup> Oct. 2025

### Group Task (4-5 members)

**Objective:** This assignment aims to deepen your understanding of fluid kinetics by exploring the Reynolds number ( $Re$ ) and its critical role in classifying flow regimes (laminar, transitional, and turbulent). You will create a computational tool to calculate  $Re$ , visualize its effects on velocity profiles and friction factors, and analyze the statistical nature of flow fluctuations.

**Submission:** Google Classroom, only one member of each team should upload the assignment deliverables.

### Deliverables

You are required to submit a complete project containing the following:

1. **Computational Script/Analysis:** A well-documented script using MATLAB (.m) file that performs the analysis below.
2. **Comprehensive Report:** A professional PDF document that includes:
  - o **Introduction:** Briefly explain the significance of the Reynolds number.
  - o **Methodology:** Describe your design approach for the MATLAB code.
  - o **Results & Discussion:** Present and discuss the findings from each part below. Include generated figures and explain their physical meaning.
  - o **Conclusion:** Summarize the key takeaways about how the Reynolds number dictates flow behavior.

**Part 1: Reynolds Number Calculator & Regime Classification**

- Calculate the Reynolds number for various fluids (e.g., water at different temperatures, air, as well as biofluids such as blood, cerebrospinal fluid, etc.), pipe diameters, pipe configurations, and flow velocities.
- Classify the flow regime based on the calculated  $Re$  (Laminar:  $Re < 2000$ , Transition:  $2000 \leq Re < 4000$ , Turbulent:  $Re \geq 4000$ ).
- Display the results in a clear, tabulated format.

**Part 2: Flow Profile Visualization**

- Plot and compare the theoretical velocity profiles for laminar (parabolic) and turbulent ( $1/7$ th power law) flows for all of the above cases.
- Create a comparative plot showing both profiles for each case.

**Part 3: Reynolds Number Effects**

- Generate a logarithmic plot of the Darcy friction factor ( $f$ ) vs. Reynolds number ( $Re$ ), showing both the laminar ( $f=64/Re$ ) and turbulent (Blasius:  $f=0.316/Re^{0.25}$ ) correlations.
- Plot velocity profiles that change shape based on different Reynolds numbers.

**Part 4: Interactive Calculator**

- Implement an interactive tool that allows a user to input fluid properties, velocity, and characteristic length to receive an instantaneous Reynolds number calculation and flow regime classification.

**Part 5: Flow Regime Concepts**

- Create streamline plots (or quiver plots) to visually represent the fluid motion in laminar (smooth, parallel), transitional (wavy, intermittent), and turbulent (chaotic, mixed) regimes.

**Bonus Points: Simulating Laminar and/or Turbulent Flow using OpenFOAM (CFD) or any other simulation tool.**

- Perform a Computational Fluid Dynamics (CFD) simulation to compare laminar and turbulent flow behavior.
- Up to +10% on the total grade, depending on the clarity and completeness of the simulation.
- **Resources:**
  - [MATLAB CFD Simulation Tutorial](#)
  - [\[Openfoam Tutorial 2\] Lid-Driven Cavity Flow](#)