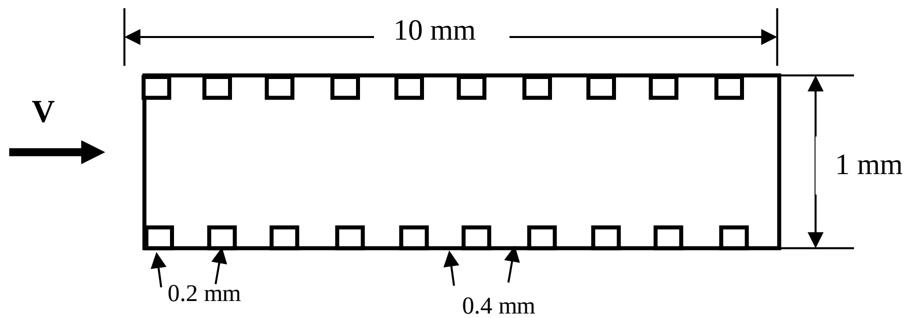
ME 527 **PART I PROJECT** **Fall 2023**

Electronic Cooling

a) For a duct, assume that there are rectangular roughness elements 0.2 mm wide and with a height of 0.1 are mounted on the duct walls with a spacing of 0.4 mm. Evaluate the flow fields for the inlet velocities of 0.01 and 0.1 m/s.



b) Assume that the elements are at a temperature of 50^{o}C, and the air at the inlet is at 20^{o}C. Evaluate the temperature field for different flow rates. Also, evaluate the net heat flux and the effective Nusselt number.

c) For the duct with and without roughness elements, assume that the airflow starts at time zero and find the unsteady airflow velocity and the temperature field. Assume that there is no flow initially, and the air temperature is at 50^{o}C. For the duct without roughness, compare your solution with the exact solution.

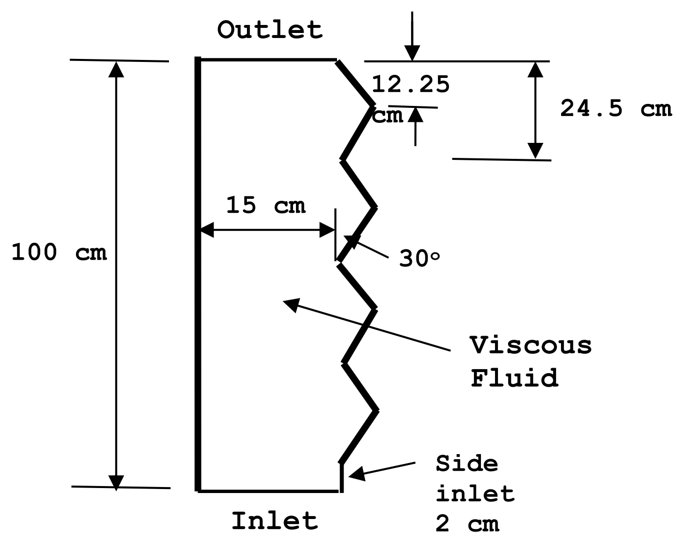
Flow and Bubbly Flow in a Rough Duct

a) For an asymmetric duct, as shown in the figure, study flows of Newtonian and non-Newtonian (power-law) fluids. Assume that the velocity at the bottom inlet is V=0.01 m/s, and the side inlet has zero velocity. Evaluate the velocity profile and pressure drop across the duct.

b) Repeat part a) when air is injected from the side inlet with a speed of 0.01m/s. Use the VOF method and consider the cases where

b) The liquid flow velocity is zero.

a) The liquid flow velocity is 0.01 m/s.



Applications of Computational Modeling to your Thesis

If you are already familiar with using the Ansys-Fluent code, you can propose a project to apply CFD to your thesis instead of the Part 1 Project.

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Similarity Solution (MATLAB)

Boundary layer flow over a wedge in similarity form reduces to the Falkner-Skan equation given as

$$f''' + ff'' + \beta(1-f'^2) = 0.$$

Here β is the angle of the wedge and is given as

$$\beta = 2m/(m+1)$$

(The velocity of the outer potential flow is given as $U \propto x^m$.)

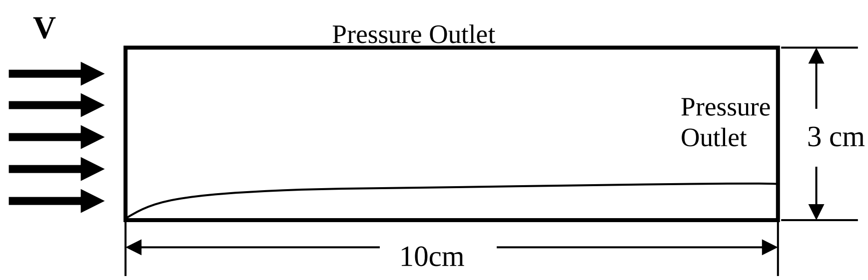
The boundary conditions are

At $\eta = 0$, $f = 0$, $f' = 0$.
At $\eta = \infty$, $f' = 1$.

Use the values of m = 0, m = 1, and m = 4, and plot f, f' and f'' versus η.
For m=0, compare the results with that obtained from ANSYS-fluent code and the exact solution.

Boundary Layer Flow (ANSYS-Fluent)

Evaluate the boundary layer flow over a flat plate. The boundary conditions for the top surface and the outlet are pressure outlets. Determine the features of the boundary layer velocity profile for the case of laminar flow and evaluate the velocity contours, velocity profiles, boundary layer thickness as a function of distance, and C_f and C_D.



Use an inlet velocity of 0.02 m/s and assume the flow is laminar.
Compare your findings with the theoretical predictions.

Report and Due Dates: The hard copies of the project reports should be submitted. Also, the electronic copies of the report, and the programs, including FLUENT CAS and DAT files, figures, and the discussion of the results, should be submitted to Moodle. The due date for Parts 1 and 2 is **December 1, 2023**.

Guideline for Technical Report Writing

First page:
Title of the project

Names of the authors and their affiliations

Abstract
Describe what is in the report, the key points, and significant findings.

Second Page
Introduction
Introduce the topic and give the background. Review the related works. In the literature survey, point to the gaps in the literature and set the stage for this work. Also, give a summary of the main findings.

Technical Report
Formulation or Experimental setup
Experimental procedure
Results and Discussion
Note that all equations should be numbered consecutively. In addition, all assumptions should be stated clearly.
Note that all figures need to be numbered consecutively, and each figure should be discussed.

Conclusions
State the conclusions of the study.

References
All references should be listed. All listed references should be referred to in the text.
Make sure to keep the same style in the references. References are given either by year or are numbered. For example,

Smith, J.D. (2000). Title of the paper. Journal of Probabilistic Mechanics, Vol. 4, pp. 345-356.

1. Smith, J.D., Title of the paper. Journal of Probabilistic Mechanics, Vol. 4, pp. 345-356 (2000).