Aerospace and Mechanical Engineering

COMPUTATIONAL FLUID DYNAMICS 2021/2022

HW3 - Passion Project

By

J. C. F. Pereira

Previous point

Ricardo Guilherme Plath Xavier

Email: ricardo.xavier@tecnico.ulisboa.pt

We have a new member of staff, Prof. Ricardo Xavier.

Not yet on the web page of CFD

The evaluation and support to the HW assignments is one of the Prof. Ricardo's duties.

In this **HW3** you are asked to put a **Question** and then to give the **Answer**

Question : establish a subject to be addressed, giving a clear idea about the 'why' this subject is pertinent, and 'how' to analyze it in order to get a conclusion

Answer: is the CFD process conducting to a conclusion

Evaluation

Question - 4 values
Answer - 16 values

Remarks:
- an excellent question without a good answer will not be valorized as excellent
- a question with no answer will be evaluated with 0 values

Passion project proposal submission

- The inherent motivation behind designing the passion project is to promote independent study, sustainable and residential learning.
- The student team group passion project proposal description (max. 400 words) should include:

1. Title of the topic selection
2. Identify 1 or 2 references from literature review
3. Summary of what to do
4. Identifying dependent and independent variables of interest

Question's validation

The Question must be sent to us (*) to validate

Only validated questions are allowed

(*) jose.chaves@tecnico.ulisboa.pt
ricardo.xavier@tecnico.ulisboa.pt

Recommendations and Constrains

- The CFD analysis must be 2D (mandatory)

- We strongly suggest you to use Star-CCM+ in the simulations. Other options need validation by (*)

- Incompressible Navier-Stokes, Transport of a Scalar and/or Heat Transfer problems are recommended

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Report

- The number of pages is limited to 11

- The first page is the cover, with your title for the subject, identification of the authors and a 'nice' picture illustrating the addressed subject

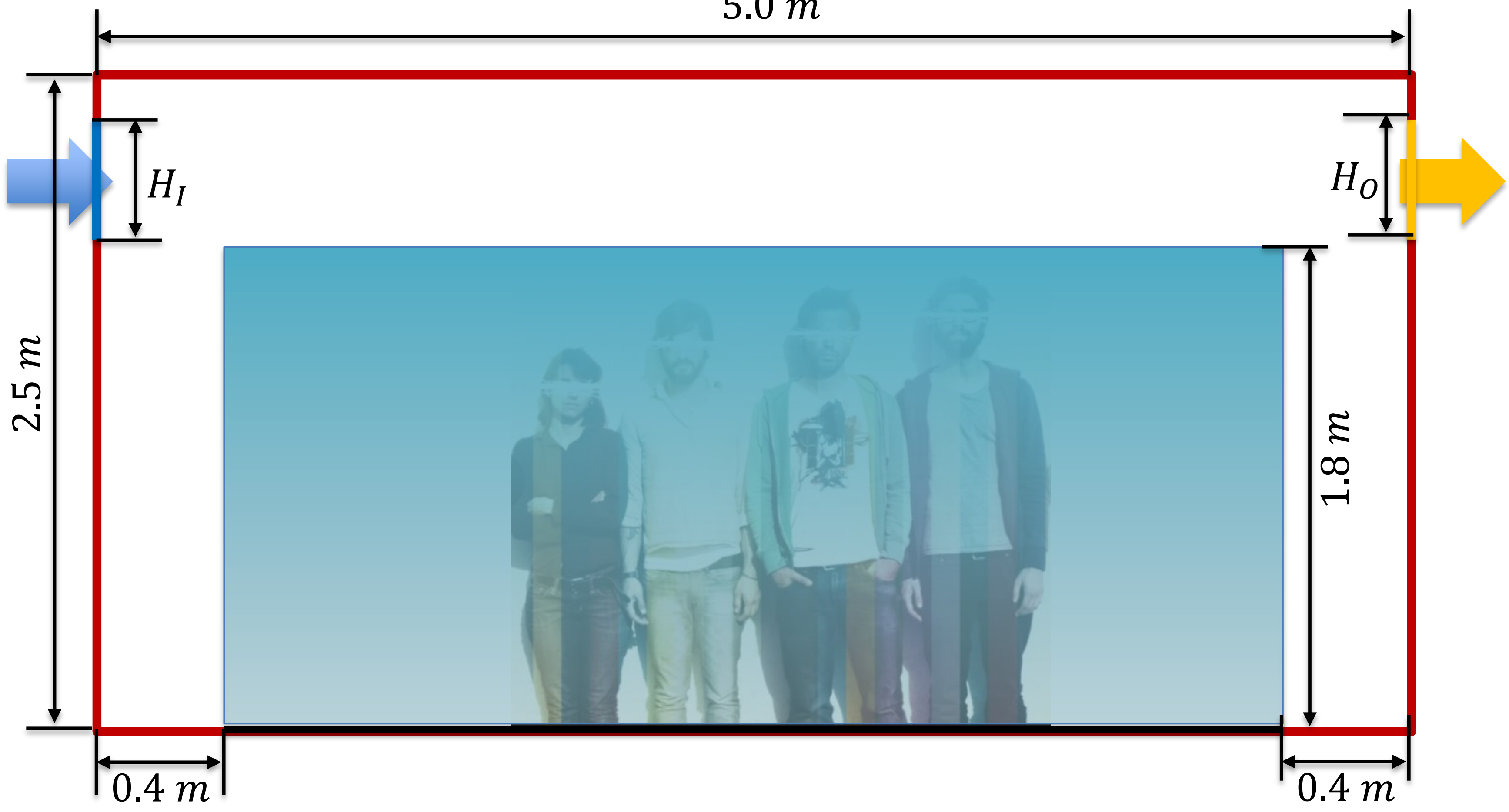
- Annexes are allowed (after page 11) but great attention to those pages is not guaranteed!!!!

By Default Question

- For those not willing to propose a Question, a 'By Default Question' is ensured, see next slides

- The Question evaluation will correspond to zero values

By Default Question



By Default Question

Consider a 2D frontal view of a room.
This room is ventilated trough an insufflation zone (blue), and the air is extracted trough the extraction zone (yellow).

For a good Indoor Air Quality and Comfort, the flow field in the occupied zone - blue rectangle - should be as uniform as possible.
For the insufflation flow rate of (per unit deep) consider $900\ m^3/h$.

Thus, the objectives are: i) to keep the field average velocity in the occupied zone as close to $0.1\,m/s$ as possible; ii) to keep the standard deviation of the velocity field in the occupied zone as close to zero as possible.

By Default Question

The height of the insufflation and extraction zones are variables to be considered but are limited to a maximum of $H_I = 0.4\,m$ and $H_O = 0.4\,m$.

The location of the insufflation and extraction zones may be anywhere in the red line.

For a 'typical' condition start with a mesh dependence analysis to establish the mesh to be used in the following steps.

With the four independent variables, define a strategy to find the 'optimum' configuration, according to the objectives above.

Also analyze the Coefficient of variation and the Turbulence intensity, not as variables to be optimized but as outcomes.

By Default Question

The Report may include the description of the followed strategy and some intermediate results to guide the reader throughout the chosen process.

Form

Velocity magnitude: $V_{mag}(x, y) = \sqrt{u(x, y)^2 + v(x, y)^2}$

Area: A $= \int_{Occupied\ Zone} 1\ dA$

Mean velocity: $\bar{V} = \dfrac{\int_{Occupied\ Zone} V_{mag}(x,y)\ dA}{A}$

Standard deviation: $\sigma = \sqrt{\dfrac{\int_{Occupied\ Zone}\left(V_{mag}(x,y)-\bar{V}\right)^2\ dA}{A}}$

Coefficient of variation: $C_v = \dfrac{\sigma}{\bar{V}}$

Mean turbulent kinetic energy: $\bar{K} = \dfrac{\int_{Occupied\ Zone} K(x,y)\ dA}{A}$

Turbulence intensity: $I_T = \dfrac{\sqrt{\frac{2}{3}\bar{K}}}{\bar{V}} \times 100$