Homework

Turbulence and CFD models: Theory and applications
Lecture 4

Task 1

Write a short program to compute estimates for the following turbulence quantities,

- Integral eddy length scale l.
- Turbulence intensity I_t.
- Turbulent kinetic energy k.
- Turbulent dissipation rate ϵ.
- Specific dissipation rate ω.
- Turbulent viscosity μ_t.
- Kolmogorov length scale η.
- Kolmogorov time scale τ_η.
- Kolmogorov velocity scale υ.
- Taylor length scale λ.
- Turbulent Reynolds number Re_T.
- Friction coefficient C_f.
- y^+ for a target value equal to 1.
- y^+ for a target value equal to 100.

Choose a case representing an internal or an external flow, and a Reynolds number in the turbulent regime.

In a separate document, you should provide the minimum instructions to run/compile the program, describe all the correlations used, and show the outcome for a least two different cases (*e.g.*, different velocities, different turbulent intensities, different corrections, etc.).

You can write the program in any of the following programming languages; Matlab, Python, C++, Fortran, Javascript. Alternatively, you can use spreadsheets (*e.g.*, excel, Google sheets, etc.).

Task 2 - Optional

Plot the Kolmogorov length scale and viscous sublayer in function of the Reynolds number, as the example shown in figure 1. You are asked to plot the viscous sublayer for three different target y^+ values; namely, $y^+ = 0.1$, $y^+ = 1$, and $y^+ = 7$.
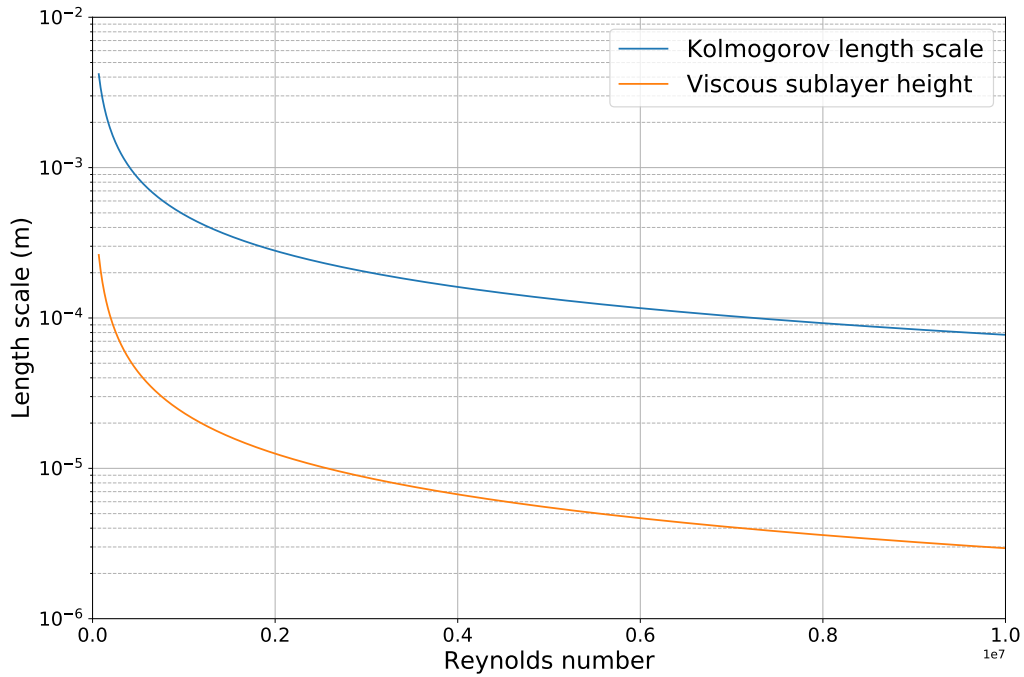

Figure 1: Comparison of Kolmogorov length scale and viscous sublayer height in function of Reynolds number (sample plot).

Question 1:
Can the Kolmogorov eddies become smaller than the viscous sublayer height? Try different combinations of input values.

Question 2:
What will happen if you choose a y^+ value equal to 60? Is this value still in the viscous sublayer? Are the Kolmogorov eddies smaller or larger?

General guidelines

- Write down all the correlations used.
- Give the units of all the quantities computed.
- If you make assumptions, remember to justify them.
- You can write your report in English or Italian.
- Do not hesitate to contact me if you have any questions.

Deadline

The deadline to submit your homework is 15 April 2020. You can send it to my email: joel.guerrero@unige.it