Aerodynamics and Fluid Mechanics 3: Laboratories for session 2020-2021 (SARS-CoV-2)

1 Introduction

This note is to help guide you through the laboratory exercise for ENG3001 Aerodynamics and Fluid Mechanics 3. In normal circumstances, laboratories run in the wind tunnels in November in semester 1 and in January in semester 2. Assessment is done in semester 2 after all the labs have been completed, students form into groups of 5 or so and a group report of the whole laboratory exercise is done, with final assessment based on the report and a group discussion in early March. Lab reports are graded, but it is a pass/ fail exercise.

There are detailed notes on the moodle page, look at the files below for a broad overview of the two laboratories.

- 'aerodynamics_and fluids_3_lab_intro.pdf'

A significant outcome of this exercise is data analysis and report writing. The intention is to guide you through the data analysis so that you can understand how to make meaningful conclusions from basic measurements.

Obviously there is significant departure for this year in comparison to the intended plan in terms of schedule, execution and timing. Please pay attention to specific instructions for this academic year 2020-2021.

2 Wind tunnel tour

The laboratory is an opportunity to see the large-scale industrial and research grade wind tunnels at University of Glasgow. These are both at the Acre Road site on the Garscube Estate, post code G20 0TL. Semester 1 laboratory

is done in the former Handley-Page wind tunnel (it was first constructed in the 1930s), and the semester 2 laboratory is done in the former deHavilland/ Hawker-Siddeley/ BAe wind tunnel (first constructed in the 1950s). The Handley-Page wind tunnel was moved to Glasgow in the 1970s after the company closed; the tunnel is of wooden construction and is contained inside a purpose-built building at Acre Road. The deHavilland wind tunnel was moved to Glasgow in the 1990s following the closure of the BAe Hatfield site. It is an all metal construction, much of it is outside and exposed the elements, but the working section is in a purpose-built building that houses all the plant and support services. Follow the link for a tour of the deHavilland wind tunnel,

- `https://www.youtube.com/watch?v=fuvjhuKZv8Q`

3 Circular cylinder laboratory (Handley-Page wind tunnel)

The laboratory theme is separated flow. A laboratory description and expected goals for the data analysis are in the file

- 'Handley_Page_tunnel_fluidslab_guidelines.pdf'

For this laboratory watch the video at the link below:

- `https://www.youtube.com/watch?v=L5clwZo2IZA`

Data files for the surface pressure data and the wake survey data are in the folder 'semester_1' . The file names are self-explanatory, they contain raw data and calibration coefficients. You should look at the file below for an explanation of the data structure,

- 'Aerodynamics_and fluids_3_lab_data_analysis_cylinder_Delta_wing.pdf'

A guidance lecture for data analysis will be given in semester 2, but background theory for the data analysis is described in the files

- 'cpcyl_theory.pdf'
- 'drag_momentum_theory_analysis_v7.pdf'

These develop the mathematics for the data analysis, you can then apply these equations to do the numerical analysis to obtain meaningful results from the data. Expectations of what you should do for this are in the file

- 'Aerodynamics_and fluids_3_lab_data_analysis_cylinder_Delta_wing.pdf'

4 Aerodynamics laboratory (deHavilland wind tunnel)

The aerodynamics laboratory involves investigation of the flow around a finite wing. It can tend to take advantage of a test model already in the wind tunnel. For session 2020-2021 a final year project investigating flow around a Delta wing was installed in the wind tunnel, and it was convenient to use this as the laboratory theme for this academic year. Note that Delta wing theory itself is not covered in the course, but the same measurements are taken as with the finite wing model that would usually be used, so much of the data analysis is identical.

A laboratory description is in the file

- 'Delta_wing_lab_notes_7hole_probe.pdf'

Watch the video walk-through at

- `https://www.youtube.com/watch?v=R6uyrvRMU5o`

Data files for the aerodynamic data are in the folder 'semester_2',

- Matlab readable .csv file 'DeltaWing2020.csv'
- Matlab .dat file 'alpha15fine_0.dat'
- Matlab script 'process_7hole_testdata_3rdyrlab_v2.m'

Force balance data are in the .csv comma-separated-variable file, the file contains the wind-off tare and the wind-on test data. 7-hole probe data are in the .dat file, which were recorded at angle of attack 15 degrees. The data file is a matlab -mat file, and can be opened using matlab. The matlab script provided will extract the velocity and pressure information from the recorded data.

Further guidance and expectations of what you should do for this are in the file

- 'Aerodynamics_and fluids_3_lab_data_analysis_cylinder_Delta_wing.pdf'

5 Conducting the data analysis, and report writing and assessment

Form groups of 5 or so students, you will divide up the data analysis tasks among yourselves. The two laboratories are not related, but note that the Delta wing leading edge vortex is due to flow separation along the wing leading edge. You will need to do some background research on flow separation around a circular cylinder and the flow around a Delta wing. Your report should be no longer than 20 numbered pages inclusive of everything. Report writing guidelines are contained in the file

- 'write_a_report.pdf'

Guideline submission date for the laboratory exercise is mid-February, you will be advised. If circumstances permit, each group will discuss the laboratory with Dr Green in early March, this will be done via zoom.