Engineering Tripos Part IIA Project, SA1: Aircraft Wing Analysis, 2020-21

Leader

Dr R Garcia-Mayoral [1]

Timing and Structure

Thursdays 11-1pm, and Mondays 9-11am plus afternoons

Prerequisites

3A1 is essential

Aims

The aims of the course are to:

- write a Matlab code that calculates the lift and drag on a 2D aerofoil section;
- design high-efficiency aerofoil sections, using numerical calculations to guide the process;
- gain an understanding of the aerodynamics of aerofoils, in particular the role of the boundary layer in limiting performance;
- obtain an appreciation of the strengths and weaknesses of CFD itself.

Content

The advent of high-performance computing has radically changed the aerospace industry's approach to wing design. In the past, wing sections were based closely on one of the wide range of standard geometries for which experimental data were already available, and optimisation was via extensive wind tunnel testing. Now, most initial section design is based on numerical calculations, with experimental work appearing later in the process. The advantage of this combined approach is that the experimental data which is the backbone of any development project is still obtained, but expensive wind tunnel tests can be targeted on the most promising designs identified by the (relatively) cheap computations. This computer-based project provides an introduction to the numerical design process, in the context of two-dimensional aerofoil sections for aeroplane wings. Programming experience above and beyond Part I computing coursework activities is not necessary.

Week 1

Write a 2D potential flow panel method. Validate via comparison with analytical solutions for standard test cases. First interim report.

Week 2

Write an integral boundary layer equation solver. Validate via comparison with theoretical and empirical results for laminar and turbulent boundary layers. Second interim report.

Weeks 3 & 4

Combine the potential flow and boundary layer routines to produce an aerofoil analysis code. Design your own 2D aerofoil sections using calculation results to guide the process. Final report.

Coursework

Coursework	Due date	
Interim report 1	Thu 14 May 2020	15
Interim report 2	Thu 21 May 2020	15
Final report	4pm Thu 4 June 2020	50

Examination Guidelines

Please refer to Form & conduct of the examinations [2].

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[1] mailto:rg471@cam.ac.uk
[2] https://teaching.eng.cam.ac.uk/content/form-conduct-examinations