HIGH SPEED AERODYNAMICS - 2024/5

Module code: ENG3215

Module Overview

This third-year module in Aerospace Engineering continues to develop the understanding of aerodynamics and aircraft design started in previous modules, by focusing on high-speed flows associated with significant compressibility effects. Nowadays, in fact, considerable research is carried out, and particular attention is given to the development of high-speed vehicles. Aerospace engineering students are then expected to have an understanding of the main analytical, numerical, and experimental methods available for the characterisation and prediction of compressible flows, as well as their societal/environmental implications. Students will learn how to predict lift and drag on supersonic bodies (wings) through main 2D and 3D theories, as well as the possibility to better develop their digital capabilities. Seminar sessions are indeed designed to engage students with digital media and digital numerical tools, as well as to make students reflect and engage on the challenges and implications of high-speed aerodynamics.

Module provider

Mechanical Engineering Sciences

Module Leader

IACOBELLO Giovanni (Mech Eng Sci)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 6

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 62

Lecture Hours: 22

Seminar Hours: 11

Tutorial Hours: 11

Guided Learning: 22

Captured Content: 22

Module Availability

Semester 2

Prerequisites / Co-requisites

N/A

Module content

Indicative content includes:
Compressible flow behaviour of nozzle flows; normal and oblique shock waves, expansion waves, and the shock-expansion theory; viscous flow and heat transfer (compressible boundary layers); design of supersonic aircraft wings (lift, drag); overview on transonic and Hypersonic flows (characteristics of hypersonic flow, Newtonian theory); lift and drag prediction using the linearised theory; Experimental methods (wind tunnels for low and high-speed flow, experimental methods).

Assessment pattern

Assessment type	Unit of assessment	Weighting
Examination	2hr exam closed book	100

Alternative Assessment

N/A

Assessment Strategy

The assessment strategy is designed to provide students with the opportunity to demonstrate an understanding of scientific principles, the ability to adapt and apply those principles to specific calculations and interpret their results, and the ability to describe aspects of aerodynamic phenomena and, more generally, aircraft design.

The summative assessment (Learning Outcomes 1-5) for this module is EXAM (100%), as reported in the "Assessment Pattern" section.

Formative assessment and feedback: unscored quizzes are provided throughout the module. Verbal feedback and discussion are provided during in-person classes; feedback is also provided via material and discussions on SurreyLearn.

Module aims

- This module aims to:

  Provide the student with a sound understanding of the main methods for predicting compressible flows in internal (ducts/nozzles) and external (boundary layers/wings) configurations, specifically for predicting lift and wave drag in supersonic flows.
- Provide a general appreciation of the physics and challenges of transonic and hypersonic flows, and simple methods for estimating lift in hypersonic flows.
- Provide an overview of the specialist experimental facilities and instrumentation used for reproducing and visualising high-speed (compressible) flows.
- Demonstrate how design choices and flow features in high-speed aerodynamics can be brought together through a broad discussion that includes thoughts on the societal/environmental/economic impact of high-speed aircraft design and operations.

Learning outcomes

Ref		Attributes Developed	
001	Be able to apply the main theories for predicting the behaviour of compressible flows, including boundary layers and nozzles.	CK	C1, C2
002	Be able to apply knowledge acquired to the general design of aircraft operating at high speed, specifically for predicting wing lift and drag in supersonic/hypersonic flight.	CK	C1, C2, C7
003	Demonstrate a comprehensive understanding of the underlying theoretical basis of the methods used for high-speed aerodynamics applications	K	C1
004	Demonstrate an awareness of the different features of compressible flow regimes (subsonic, transonic, supersonic, hypersonic), and be able to apply appropriate models for flow characterisation.	CK	C1, C3
005	Demonstrate an awareness of the design and operation of the main classes of experimental facilities, and the associated instrumentation, for high speed aerodynamics	KT	C13

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to develop subject knowledge through theory, applications and worked examples. In particular, the Teaching/learning strategy is conceived to provide students with the possibility to learn via various sources (including digital resources) and approaches (lectures, seminar discussions, guided learning, etc). Furthermore, opportunities for in-semester feedback are provided through tutorials, an online discussion forum, and seminar sessions, which all allow students to actively engage with the module convener as well as other students.

The module content is delivered through: (i) lectures covering the main theoretical aspects; (ii) seminar sessions aimed at showcasing real-world applications, enabling discussion and engagement via Q&A; (iii) tutorial classes focused on solving practical exercises and the discussion of their solution; and (iv) SurreyLearn/external material complementing lectures. Revision sessions are also planned to allow students to test their understanding and receive feedback at key stages within the module.

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: ENG3215

Other information

The School of Mechanical Engineering Sciences is committed to developing graduates with strengths in Employability, Digital Capabilities, Global and Cultural Capabilities, Sustainability, and Resourcefulness and Resilience. This module is designed to allow students to develop knowledge, skills, and capabilities in the following areas:

Digital Capabilities: Students will use digital media to engage in learning activities, use digital tools (such as Excel and Matlab) to solve problems and enhance the learning experience, as well as access digital material for in-semester feedback.

Employability: Students will be provided with the opportunity to discuss real-world engineering cases through face-to-face discussion sessions and - based on speaker availability - engage with industry professionals via ad hoc seminar; students will hence have the opportunity to reflect critically on their own practice and learning in relation to Industry.

Sustainability: Students will engage in discussions with peers and the module convener on the theme of sustainable aviation via weekly seminars, specifically on the impact of high-speed aircraft aerodynamics on the environment.

Resourcefulness and resilience: Students will engage with peers and module convener to make informed and constructive contributions to class debates, thus demonstrating openness to considering other perspectives; opportunities will also be given to students to develop a responsive attitude to formative feedback (mainly received through tutorials and review sessions) as well as to peer-to-peer feedback, recognising opportunities for enhanced learning building on prior experience.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Aerospace Engineering BEng (Hons)	2	Optional	A weighted aggregate mark of 40% is required to pass the module
Aerospace Engineering MEng	2	Optional	A weighted aggregate mark of 40% is required to pass the module