Module specification

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Module Code	ENG687
Module Title	Aerodynamics
Level	6
Credit value	20
Faculty	FAST
HECoS Code	100428
Cost Code	GAME

Programmes in which module to be offered

Programme title	Is the module core or option for this programme
BEng (Hons) Aeronautical Engineering	Core
MEng Aeronautical Engineering	Core

Pre-requisites

None

Breakdown of module hours

Learning and teaching hours	24 hrs
Placement tutor support	0 hrs
Supervised learning e.g. practical classes, workshops	0 hrs
Project supervision (level 6 projects and dissertation modules only)	0 hrs
Total active learning and teaching hours	24 hrs
Placement / work based learning	0 hrs
Guided independent study	176 hrs
Module duration (total hours)	200 hrs

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Initial approval date	Feb 2017
With effect from date	Sept 2022
Date and details of revision	Aug 2022: Learning outcomes and assessment update in Engineering revalidation

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Version number	V2

Module aims

- To develop an understanding of the properties of the atmosphere, the effect of forces on the aerodynamic characteristics of aircraft and vehicles, the mechanics of flight and aircraft performance.
- To develop an understanding of processes involved practical experience at deriving solutions for engineering tasks.
- To extend and develop understanding of the aerodynamic characteristics of a 3D wing from 2D aerofoil in both incompressible and compressible flow regimes.

Module Learning Outcomes - at the end of this module, students will be able to:

1	Calculate and analyse the aerodynamic characteristics of aircrafts/vehicles/wings.
2	Apply the mechanics of airflows to aircraft/vehicle performance.
3	Apply the aerodynamic characteristics of wings with various profiles under various flow regimes (subsonic incompressible, subsonic compressible, transonic, supersonic).
4	Analyse boundary layer development on a flat plate, which can be used to approximately estimate boundary layer development on an aerofoil.

Assessment

Indicative Assessment Tasks:
This section outlines the type of assessment task the student will be expected to complete as part of the module. More details will be made available in the relevant academic year module handbook.

The assessment of this module consists of two parts:

1. Written Assignment – Students will conduct an analytical experiment using the Wind Tunnel and a written report will be submitted for the assessment. The candidate's word count is 2000 words.
2. Exam – At the end of semester, candidates will sit in an unseen written exam. This exam will have a 2hr duration

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)
1	1	Written Assignment	50%
2	2,3,4	Examination	50%

Derogations

A derogation from regulations has been approved for this programme which means that whilst the pass mark is 40% overall, each element of assessment (where there is more than one assessment) requires a minimum mark of 30%.

Learning and Teaching Strategies

The module will be presented to students through a series of lectures, tutorials and case studies utilising laboratory equipment such as Wind Tunnels where appropriate. Relevant video material will be used to strengthen topics from within the module. This module maybe undertaken synchronously, or asynchronously, and could be delivered face to face, or via online methods.

The module is taught through a combination of lectures and workshops. An active and inclusive approach is used to engage learners in the topics and will involve individual, group work and flipped learning experiences aligned to the university's Active Learning Framework (ALF). The approach offers students a flexible and adaptive learning experience that can accommodate a range of options that includes both on campus learning and remote learning where appropriate.

The Moodle VLE and other on-line materials and resources will be available to support learning. ALF offers a balance between the classroom elements and digitally enabled activity incorporating flexible and accessible resources and flexible and accessible feedback to support learning.

Indicative Syllabus Outline

Properties of the atmosphere: Properties of air: Ideal gas law.

Aeronautical definitions: Structures of an airplane. Aerofoil geometry. Angle of attack

Effect of forces on the aerodynamic characteristics of aircraft and vehicles: Forces of importance: thrust, lift and drag. Moments. Centre of Gravity, Centre of Pressure, and Aerodynamic centre. Relationship between these positions.

Dimensional analysis and similarity: Importance of dimensional analysis and model testing in engineering. Dimension and unit. Dimensional homogeneity. Dimensional analysis method. Common non-dimensional groups. Three similarities: geometric, kinematic and dynamic.

Aerodynamic characteristics: Reynolds number, Mach number, coefficients of lift, drag and moment.

Viscous flow and boundary layers: Velocity profile. Boundary layer development on a flat plate. Laminar and turbulent boundary layer. Boundary layer separation. Boundary thickness.

General external flow characteristics Lift and drag generation. Pressure distribution around a cylinder. Variation of pressure distribution with angle of attack of an airfoil. Types of drags: skin drag, form drag, interference drag, induced drag and wave drag.

Mechanics of flight and vehicle performance: Flight: Forces involved in climbing flight, gliding flight. Rate of descent and endurance. Criteria for aircraft control in a horizontal turn. Maximum range/endurance conditions for engine types. Land vehicles: this section can consider aerodynamic forces at different velocities, turns, effects of aerofoils, efficiency, power.

Compressible Flow: Wave propagation in compressible flow. Mach number relationships. Compressible flow regime analysis: subsonic flow at high Mach number, transonic and supersonic. Wings in compressible flow. Prandtl-Glauert correction factor and critical Mach number. Lift and drag on supersonic moving aerofoils. Lift and drag in the transonic region.

Indicative Bibliography:

Please note the essential reads and other indicative reading are subject to annual review and update.

Essential Reads

J.D. Anderson, *Fundamentals of Aerodynamics*, 6th ed. McGraw-Hill Education, 2016.

Other indicative reading

E. L. Houghton, and P. W. Carpenter, *Aerodynamics for Engineering Students*, 7th ed. Butterworth-Heinemann, 2016.

J. D. Anderson, *Introduction to Flight*, 8th ed. McGraw-Hill Higher Education, 2015.

L. Dingle and M. Tooley, *Aircraft Engineering Principles*, 2nd ed. Routledge, 2013.

Employability skills – the Glyndŵr Graduate

Each module and programme is designed to cover core Glyndŵr Graduate Attributes with the aim that each Graduate will leave Glyndŵr having achieved key employability skills as part of their study. The following attributes will be covered within this module either through the content or as part of the assessment. The programme is designed to cover all attributes and each module may cover different areas.

Core Attributes
Engaged
Enterprising
Ethical

Key Attitudes
Commitment
Curiosity
Resilience
Confidence
Adaptability

Practical Skillsets
Digital Fluency
Organisation
Critical Thinking
Emotional Intelligence
Communication