Module Specification

Aero-Elasticity

Version: 2025-26, v6.0, Approved

Contents

Part 1: Information

Module title: Aero-Elasticity

Module code: UFMEWC-15-M

Level: Level 7

For implementation from: 2025-26

UWE credit rating: 15

ECTS credit rating: 7.5

College: College of Arts, Technology and Environment

School: CATE School of Engineering

Partner institutions: None

Field: Engineering, Design and Mathematics

Module type: Module

Pre-requisites: Aero Structures 2025-26

Excluded combinations: None

Co-requisites: None

Continuing professional development: No

Professional, statutory or regulatory body requirements: None

Part 2: Description

Overview: The module examines aeroelasticity and its implications for aircraft design. Students will learn both theoretical and experimental methods to model, predict, and validate aeroelastic effects, integrating them into the engineering design process.

Features: Not applicable

Educational aims: The aim of this module is to equip students with a comprehensive understanding of aeroelastic phenomena, including flutter and divergence. It integrates theoretical principles with computational and experimental methods. Additionally, the module aims to develop the skills necessary to model, predict, and validate the dynamic behaviour of aircraft structures when subjected to aerodynamic loading.

Outline syllabus: Topics covered likely to include but not limited to:

Flutter and divergence modelling. Flutter and divergence speed prediction. 2 D.O.F. flutter equation, Classical equations to predict flutter speeds. Structural modes, Eigen-problem solution. Aeroelastic frequencies, damping ratios and mode shapes calculation using eigenvalues and eigenvectors.

Aerodynamic modelling and static aeroelasticity: Static divergence and Control reversal. Strip theory. Unsteady aerodynamics: Theodorsen model. Aerodynamic stiffness and damping ratio.

Structural modelling: Stiffness properties, Calculation of wing modes and inertias. Effects of mass, flexural axis, frequency parameter, and density on the flutter solution. Structural damping modelling. Lagrangian equations, torsional and bending beam theory. Bending and torsion coupling.

Experimental: Ground Vibration Tests. Introduction to Operational and Experimental Modal Analysis. Eigenfunction Realisation Algorithm (ERA). Structural System Identification Methods for Structural Properties. Stabilisation Diagrams.

Part 3: Teaching and learning methods

Teaching and learning methods: Students will learn through a combination of formal lectures and tutorial sessions. The lectures will focus on delivering key concepts of the aeroelasticity discipline, while tutorials will demonstrate to students how to numerically and computationally predict aeroelastic behaviours. The module will also include lab sessions that focus on practical applications of experimental aerodynamics.

Module Learning outcomes: On successful completion of this module students will achieve the following learning outcomes.

MO1 Identify wing flutter and divergence and estimate their characteristic speeds.

MO2 Apply experimental methods to identify wing structural properties for aeroelastic modelling.

MO3 Apply the principles of aeroelasticity to predict the structural response of an aircraft subject to elastic, inertial and unsteady aerodynamic loads.

Hours to be allocated: 150

Contact hours:

Independent study/self-guided study = 114 hours

Face-to-face learning = 36 hours

Reading list: The reading list for this module can be accessed at readinglists.uwe.ac.uk via the following link https://uwe.rl.talis.com/modules/ufmewc-15-m.html

Part 4: Assessment

Assessment strategy: The final assessment consists of a 10-page individual report resembling an experimental report for an aeroelastic test. Students will be required to describe the numerical modelling of a cantilever wing and its validation through experimental testing. The results must demonstrate the predictions of the wing's aeroelastic response, including flutter and divergence speeds.

Additionally, students will present their work in a 10-minute presentation, followed by a VIVA-style Q&A session where their work will be discussed in detail.

The resit assessment will be the same as the first sit.

Assessment tasks:

Report (First Sit)
Description: This is a 10-page (max) technical report describing the modelling and validation of a cantilever wing.
Weighting: 50 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO2

Presentation (First Sit)
Description: 10-minute presentation on their work, followed by a 30-minute Q&A session.
Weighting: 50 %
Final assessment: No
Group work: No
Learning outcomes tested: MO2, MO3

Report (Resit)
Description: This is a 10-page (max) technical report describing the modelling and validation of a cantilever wing.
Weighting: 50 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO2

Presentation (Resit)
Description: 10-minute presentation on their work, followed by a 30-minute Q&A session.
Weighting: 50 %
Final assessment: No
Group work: No
Learning outcomes tested: MO2, MO3

Part 5: Contributes towards

This module contributes towards the following programmes of study:

Aerospace Engineering (Design) [Sep][PT][Frenchay][8yrs] MEng 2018-19

Aerospace Engineering [Sep][SW][Frenchay][5yrs] MEng 2021-22

Aerospace Engineering with Pilot Studies [Frenchay] MEng 2022-23

Aerospace Engineering [Frenchay] MEng 2022-23

Aerospace Engineering with Pilot Studies [Frenchay] MEng 2022-23

Aerospace Engineering [Frenchay] MEng 2022-23

Aerospace Engineering [Sep][PT][Frenchay][8yrs] MEng 2018-19

Aerospace Engineering with Pilot Studies [Sep][SW][Frenchay][5yrs] MEng 2021-22

Aerospace Engineering [Frenchay] MEng 2022-23

Aerospace Engineering with Pilot Studies [Frenchay] MEng 2022-23