Module Specification

Aero-Elasticity

Version: 2021-22, v3.0, 07 Jun 2022

Contents

Part 1: Information

Module title: Aero-Elasticity

Module code: UFMEWC-15-M

Level: Level 7

For implementation from: 2021-22

UWE credit rating: 15

ECTS credit rating: 7.5

Faculty: Faculty of Environment & Technology

Department: FET Dept of Engineering Design & Mathematics

Partner institutions: None

Delivery locations: Frenchay Campus

Field: Engineering, Design and Mathematics

Module type: Standard

Pre-requisites: Aero Structures 2021-22

Excluded combinations: None

Co-requisites: None

Continuing professional development: No

Professional, statutory or regulatory body requirements: None

Part 2: Description

Overview: Module Entry requirements: The module is intended for science and engineering graduates, or equivalent, with strong mathematical skills.

Pre-requisites: students must take UFMFX6-15-2 Aerostructures and either: UFMFY6-30-2 Aerodynamics and Flight or UFMF9C-30-2 Pilot studies & Aerodynamics

Features: Not applicable

Educational aims: See learning outcomes.

Outline syllabus: Introduction: Flutter, Aero-elasticity, Modes, Properties of stiffness matrices, freefree, applying constraints, Fixed root modes, Eigen solution Orthogonality of normal modes and transformation of multi-degree of freedom systems into modal equations, Free-free modes

Basic considerations: Wing inertial and flexural axes, Control surfaces, Static divergence, Control reversal, Influence on design, Strip theory – single element, Unsteady aerodynamics, Theodorsen, Minhinnick, frequency parameters, Aerodynamic stiffness and damping, Structural damping, 2 D.O.F. flutter equation, Classical equations to predict flutter speeds, Addition of control surfaces

Multi-strip fixed root wing bending torsion flutter: Stiffness properties, Calculation of wing modes and inertias, Orthogonal transform of mass and stiffness matrices to obtain modal set, 5 strip wing aerodynamics, Interpolate mode shapes onto strips, Assemble aerodynamic stiffness and damping, Flutter solution – needs flutter solution algorithm available, Effects of mass, flexural axis, frequency parameter, density, Types of flutter solution, matched and unmatched frequency parameter

Control surface flutter: How controls work, Attachment and control stiffness, Add freedom to wing model, Control surface flutter derivatives

Laboratory demonstration of free-free modes: Simple free-free beam, Shake test, Symmetric/asymmetric modes, Mode measurement and plotting

Free-free modes flutter: Symmetric/asymmetric, Symmetric flutter – pitch, vertical freedom and bending torsion, Comparison of mode shapes/inertias with fixed wing calculations earlier, Flutter analysis

Airframe modal characteristics: Wings, Tails, Engines, Weapons/stores, Complete airframe, Measuring modes, Representing free-free modes, Shake tests methods, Back to free-free model – prediction of forced response to shaker input – student exercise

Flutter testing: Purpose, Design requirements, Single, multiple failures, Store combinations, Excitation methods, Analysis methods, Telemetry, Flight envelope, Achieving speeds, Critical parts of envelope, Control system failure cases, Safety.

Part 3: Teaching and learning methods

Teaching and learning methods: Students will learn through a combination of formal lectures and tutorials sessions.

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

MO1 Key principles of aero-elasticity, theoretical considerations coupled with experiments

MO2 The aspects of flutter

MO3 The classical equations to predict flutter

MO4 The experimental methods and analysis of flutter

MO5 The physics of aero-elasticity for an aircraft and its components

MO6 The effects of mass, flexural axis, frequency parameter, types of flutter solutions

MO7 The numerical/experimental data from a control surface

MO8 Calculations of the free-free mode flutter

MO9 Design requirements including flutter

MO10 Modelling of a control surface flutter

MO11 The practical issues of dynamic measurements and analysis and testing

MO12 Awareness of professional literature

MO13 Problem formulation and decision making

MO14 Self-management skills

Hours to be allocated: 150

Contact hours:

Independent study/self-guided study = 114 hours

Face-to-face learning = 36 hours

Total = 150

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 module is examined via an exam which will cover the taught issues.

Assessment components:

Examination (Online) - Component A (First Sit)
Description: Online examination: 5 hours
Weighting: 100 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO10, MO11, MO12, MO13, MO14, MO2, MO3, MO4, MO5, MO6, MO7, MO8, MO9

Examination (Online) - Component A (Resit)
Description: Online examination: 5 hours
Weighting: 100 %
Final assessment: Yes
Group work: No
Learning outcomes tested:

Part 5: Contributes towards

This module contributes towards the following programmes of study:

Aerospace Engineering with Pilot Studies (Design) [Sep][FT][Frenchay][4yrs] MEng 2018-19

Aerospace Engineering (Design) [Sep][FT][Frenchay][4yrs] MEng 2018-19

Aerospace Engineering with Pilot Studies [Sep][FT][Frenchay][4yrs] MEng 2018-19

Aerospace Engineering [Sep][FT][Frenchay][4yrs] MEng 2018-19