MODULE SPECIFICATION

Part 1: Information			
Module Title	Aero-Elasticity		
Module Code	UFMEWC-15-M	Level	Level 7
For implementation from	2019-20		
UWE Credit Rating	15	ECTS Credit Rating	7.5
Faculty	Faculty of Environment & Technology	Field	Engineering, Design and Mathematics
Department	FET Dept of Engin Design & Mathematics		
Module type:	Standard		
Pre-requisites	Aero Structures 2019-20		
Excluded Combinations	None		
Co- requisites	None		
Module Entry 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

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.

Teaching and Learning Methods: Students will learn through a combination of formal lectures and tutorials sessions.

Part 3: Assessment

The module is examined via an exam of 3 hours which will cover the taught issues.

First Sit Components	**Final Assessment**	**Element weighting**	**Description**
Examination - Component A	✓	100 %	Exam (180 minutes)
Resit Components	**Final Assessment**	**Element weighting**	**Description**
Examination - Component A	✓	100 %	Exam (180 minutes)

Part 4: Teaching and Learning Methods

Learning Outcomes

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

Module Learning Outcomes	Reference
Key principles of aero-elasticity, theoretical considerations coupled with experiments	MO1
The aspects of flutter	MO2
The classical equations to predict flutter	MO3
The experimental methods and analysis of flutter	MO4
The physics of aero-elasticity for an aircraft and its components	MO5
The effects of mass, flexural axis, frequency parameter, types of flutter solutions	MO6
The numerical/experimental data from a control surface	MO7
Calculations of the free-free mode flutter	MO8
Design requirements including flutter	MO9
Modelling of a control surface flutter	MO10
The practical issues of dynamic measurements and analysis and testing	MO11
Awareness of professional literature	MO12
Problem formulation and decision making	MO13
Self-management skills	MO14

Contact Hours

Independent Study Hours:	
Independent study/self-guided study	114
Total Independent Study Hours:	114
Scheduled Learning and Teaching Hours:	
Face-to-face learning	36
Total Scheduled Learning and Teaching Hours:	36
Hours to be allocated	150
Allocated Hours	150

Reading List

The reading list for this module can be accessed via the following link:

https://uwe.rl.talis.com/modules/ufmewc-15-m.html

Part 5: Contributes Towards

This module contributes towards the following programmes of study: