University of the West of Scotland

Module Descriptor

Session: 2024/25

Title of Module: Applied Finite Element Analysis			
Code: ENGG11022	**SCQF Level: 11 (Scottish Credit and Qualifications Framework)**	**Credit Points: 20**	**ECTS: 10 (European Credit Transfer Scheme)**
School:	School of Computing Engineering and Physical Sciences		
Module Co-ordinator:	Dr Obeid Obeid		

Summary of Module

The role of computational based analysis and simulation techniques are proving to be ever more critical as enabling technologies in the engineering and design environment Finite Element Analysis (FEA) is a major analysis tool for the simulation and assessment of components and systems.

This module will introduce students to advantages, disadvantages and limitations of different FE methodologies, exemplifying these by application of the methods to practical engineering and design problems.

An introduction to traditional H-type element formulation will be presented for beam, 2D planar, 3D shell and solid elements. Solution methods and routines will be discussed as applicable to the analysis type.

Module content will focus on modeling strategies and techniques. Types of modeling such as solid, shell, plane stress and strain techniques, axisymmetric and beam modeling will be discussed and demonstrated. Modeling issues will be highlighted such as the use of symmetry, error issues and convergence checking. Sensitivity studies will be dealt with in a practical manner. Effects of element formulation, equivalent nodal loading, solution schemes, element results, nodal averaging, and constraints will be discussed and assessed. Combination of element types within an analysis will be explored, with various modeling approaches demonstrated.

During the course of this module students will develop their UWS Graduate Attributes (https://www.uws.ac.uk/current-students/your-graduate-attributes/). Universal: Academic attributes - critical thinking and analytical & inquiring mind; Work-Ready: Academic attributes - knowledge of FEA and CFD and relevant ICT skills; Successful : autonomous, driven and resilient.

This module will start with a small displacement linear elastic FE analysis and progress to advanced modelling with geometric and material nonlinearities with applications. Assessment will be by means of a major coursework/case study submission. During the course of this module students will gain knowledge and understanding of this important discipline as well as having the opportunity to develop a broad range of ICT, technical and transferable skills. Subject matter will be delivered mainly by an innovative programme of laboratory demonstrations and class assignments where the practical nature of the module will be emphasised and students will gain experience in using state of the art FEA systems. A complementary series of lectures and presentations will also be used to

reinforce the subject matter.

This module has been reviewed and updated, taking cognisance of the University's Curriculum Framework principles. Examples of this are found within the module such as active and engaging laboratory and digital tutorial activity, module assessment which reflects industry Computer Aided Engineering activities, learning synergies across modules and levels of study, recorded lecture content supporting students to organise their own study time and the use of real-world practical problems with experimental data to validate simulation activity developing digital intelligence meta-skills.

Module Delivery Method

Face-To-Face	Blended	Fully Online	HybridC	Hybrid 0	Work-Based Learning
☒	☐	☐	☐	☐	☐

See Guidance Note for details.

Campus(es) for Module Delivery

The module will **normally** be offered on the following campuses / or by Distance/Online Learning: (Provided viable student numbers permit) (tick as appropriate)

Paisley:	Ayr:	Dumfries:	Lanarkshire:	London:	Distance/Online Learning:	Other:
☒	☐	☐	☐	☐	☐	

Term(s) for Module Delivery

(Provided viable student numbers permit).

Term 1	☐	Term 2	☒	Term 3	☐

Learning Outcomes: (maximum of 5 statements)
At the end of this module the student will be able to:

L1	Develop an in-depth comprehensive knowledge and critical understanding of the theory and application of analysis and simulation systems currently used in a design and analysis engineering environment
L2	Apply advanced skills and techniques, in the application of Finite Element Analysis, to solve practical case studies and complex design problems, reaching substantiated solutions
L3	Demonstrate a critical analysis and assessment of a Finite Element Analysis

L4	Design solutions for complex problems that evidence originality using advanced FEA for problems involving linear elastic small displacement, eigenvalue and eigenvector vibration and buckling, nonlinearity and time dependencies
L5	Adopt a holistic and proportionate approach to the mitigation of security risks

Employability Skills and Personal Development Planning (PDP) Skills	
SCQF Headings	During completion of this module, there will be an opportunity to achieve core skills in:
Knowledge and Understanding (K and U)	SCQF Level **11** A critical knowledge and understanding of finite element methods and techniques and how these fit into engineering and design strategies. Specific and detailed knowledge and understanding of the application, techniques and practices associated with finite element analysis of engineering and design problems. Detailed knowledge of appropriateness of methods and techniques to different problems/scenarios.
Practice: Applied Knowledge and Understanding	SCQF Level **11** Select and critically evaluate technical literature and other sources of information to solve complex problems Applying knowledge and understanding to develop modelling and analysis strategies for a wide range of engineering and design problems, using finite element method techniques. Assessing different strategies with respect to obtaining appropriate efficient solutions to engineering and design problems. Making use of specialised finite element techniques to solve engineering and design problems such as optimisation methods or open ended problems.
Generic Cognitive skills	SCQF Level **11** Undertaking, evaluating and assessing critical FE analysis data. Making judgements on analytical data and results. Being able to develop conceptual solutions and strategies to FE problems. Dealing with unpredictability in results and making critical comparative assessments between theoretical, simulation, and experimental predictions.

	Bringing information together from a variety of sources during problem solving and being able to perceive potential problems with methods and strategies.	
Communication, ICT and Numeracy Skills	SCQF Level **11** Ability to perform, interpret and evaluate complex numerical, geometrical and graphical data and using it to solve problems. Ability to use variables and equations. Ability to integrate existing software with other applications such as spread sheets. Make use of multi-purpose integrated software systems to solve complex problems. Using communications skills to write detailed, critical technical reports, including text and illustration. Using finite element hardware and software and associated ICT equipment and systems such as networks to support and perform a wide range of problem solving tasks.	
Autonomy, Accountability and Working with others	SCQF Level **11** Identifying and addressing their own learning needs both during and outwith class time. Identifying solution routes and strategies using their own initiative and informed judgements.	
Pre-requisites:	Before undertaking this module the student should have undertaken the following:	
	Module Code:	**Module Title:**
	Other:	
Co-requisites	**Module Code:**	**Module Title:**

*Indicates that module descriptor is not published.

Learning and Teaching	
This module will be delivered via a blend of lectures, laboratory examples of real engineering problems. Assessment will be via a in class assignments to explore fundamental issues. A major coursework/case study assignment of a real design problem will be compared with actual test results.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Normally totalling 200 hours): (Note: Learning hours include both contact hours

	and hours spent on other learning activities)
Lecture/Core Content Delivery	24
Tutorial/Synchronous Support Activity	12
Independent Study	164
	Hours Total 200

****Indicative Resources: (eg. Core text, journals, internet access)**

The following materials form essential underpinning for the module content and ultimately for the learning outcomes:

Finite Element Analysis Systems (such as PTC Creo Parametric/Simulate, ANSYS) + 40 seat PC Lab with corresponding network facilities and suitable PCs. Software site licences are required.

NAFEMS QSS Primer 2014, NAFEMS, 2014

NAFEMS Simulation Handbook –Structural Linear Statics, NAFEMS, 2014 Finite Element Analysis for Engineers - A Primer, NAFEMS, 2013

Finite Element Analysis of Composite Materials Using Ansys, E. Barbero, CRC Press, 2014

Finite Element Modeling and Simulation with ANSYS Workbench, X. Chen & Y. Liu, CRC PRESS, 2015

(**N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

Attendance and Engagement Requirements

In line with the Student Attendance and Engagement Procedure: Students are academically engaged if they are regularly attending and participating in timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time.

Equality and Diversity

The University's Equality, Diversity and Human Rights Procedure can be accessed at the following link: UWS Equality, Diversity and Human Rights Code.

(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)

Supplemental Information

Divisional Programme Board	Engineering and Physical Sciences
Assessment Results (Pass/Fail)	Yes ☐No ☒
School Assessment Board	Engineering
Moderator	Tony Leslie
External Examiner	F Inam
Accreditation Details	This module is part of the IMechE accredited programmes BEng/Meng (Hons) Aircraft and BEng/Meng (Hons) Mechanical Engineering.
Changes/Version Number	1.09 (was 1.08) Module Delivery Changed to Face-To-Face from Hybrid C. Assessment terminology made consistent between Assessment Grid and assessment description.

Assessment: (also refer to Assessment Outcomes Grids below)
Case study on Basic FEA Modelling & Analysis 50%
Case study on Non-linear Modelling & Analysis 50%
(N.B. (i) **Assessment Outcomes Grids** for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An **indicative schedule** listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Module Handbook.)

Assessment Outcome Grids (See Guidance Note)

Component 1							
Assessment Type (Footnote B.)	**Learning Outcome (1)**	**Learning Outcome (2)**	**Learning Outcome (3)**	**Learning Outcome (4)**	**Learning Outcome (5)**	**Weighting (%) of Assessment Element**	**Timetabled Contact Hours**
Case Study	✓	✓	✓	✓		50	0

Component 2							
Assessment Type (Footnote B.)	**Learning Outcome (1)**	**Learning Outcome (2)**	**Learning Outcome (3)**	**Learning Outcome (4)**	**Learning Outcome (5)**	**Weighting (%) of Assessment Element**	**Timetabled Contact Hours**
Case Study		✓	✓		✓	50	0
Combined Total for All Components						**100%**	**2 hours**