MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

16429 COMPUTER AIDED ENGINEERING DESIGN

Module Registrar: Prof. Marcello Lappa marcello.lappa@strath.ac.uk	**Taught To (Course): Cohorts for whom module is compulsory**	
Other Lecturers Involved: Dr Yevgen Gorash	**Credit Weighting: 20 (ECTS 10)**	**Semester: 1 and 2**
Compulsory module	**Academic Level: 4**	**Suitable for Exchange: Y**

Required prerequisites

Note: It is the responsibility of ALL students to ensure that they satisfy the prerequisite knowledge for this module BEFORE adding as part of curriculum selection. If unsure, please contact the Module Registrar or discuss with your Programme/Year Adviser of Studies.

1. Physics Fundamentals of kinematics and dynamics, forces and momenta, work and energy, typical properties of gases and liquids, basic heat transfer mechanisms related to conduction and convection, balance equations for mass, momentum and energy in integral form.
2. Mathematics: Fundamentals of linear algebra, vectors & matrices, scalar product, vector product, tensor calculus, functions of several variables and related derivatives; surface and volume integrals.
3. Numerical Methods: Solution of algebraic linear and nonlinear equations, integration of ordinary differential equations.
4. Understanding of the basic theory of the Finite Element Method (FEM) and Computational Fluid Dynamics (CFD);
5. Be able to use FEM software ANSYS Workbench to solve linear mechanical problems and CFD software FLUENT to solve various simplified practical engineering problems.
6. Understanding of how mathematics, mechanics of materials, numerical analysis and computing technology are combined to model and simulate the behaviour of physical systems.

Special NOTE for Biomedical Engineering students: Given the specific stream in which they are enrolled, they often lack the necessary skills for a discipline/class like this, where a strong mathematical background is needed. Before taking this class, they should verify that they satisfy all the prerequisites listed above.

Module Format and Delivery (HOURS i.e. 1 credit = 10hrs of study):

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
16	12	52					40	80	200

Educational Aim

This module aims to provide an appreciation of computer aided design, analysis and simulation methods over a range of engineering problems and to provide practical experience of the use of simulation and analysis software to design and investigate the behaviour and performance of specific systems or components.

Learning Outcomes

On completion of the module the student is expected to be able to:

LO1 employ a finite element analysis (FEA) software effectively for the design of components and systems for linear and non-linear stress analysis.

LO2 employ computational fluid dynamics (CFD) software effectively to tackle real-world engineering problems.

Syllabus

The module will teach the following:

Section 1
Engineering problem solving using finite element analysis (FEA) applied to a range of practical and industrially relevant stress analysis. Expanded usage of mechanical FEA in linear elastic, non-linear and dynamic problems. Solid modelling, application of boundary and initial conditions, practical modelling, verification of models and analysis, post-processing and checking of results. Dynamics: Modal and Harmonic Analysis; Nonlinear Limit Analysis; Fatigue Analysis.

Section 2
Fluid dynamics problem solving using finite volume and finite differences methods. Illustration of the critical links existing between purely theoretical CFD aspects and common industry-leading software packages and related "options" (solution methods, numerical schemes, resulting accuracy, turbulence models, etc.). Utilisation of commercial CFD software for the effective solution of practical problems (e.g., external or internal turbulent flow; heat and mass transfer problems in plants, etc).

Assessment of Learning Outcomes

Criteria

For each of the Module Learning Outcomes the following criteria will be used to make judgements on student learning:

LO1
C1 Describe the software tools being used, highlighting their advantages and disadvantages.
C2 Develop a modelling strategy (highlighting assumptions) and select appropriate idealisations which are compatible with the objectives of the analysis and simulation being undertaken.
C3 Employ an analysis and simulation system to achieve the objectives of the task set and to validate the results obtained as far as practical.
C4 Demonstrate sound engineering judgement and effective communication skills.

LO2
C1 Describe the software tools being used, highlighting their advantages and disadvantages.
C2 Develop a modelling strategy (highlighting assumptions) and select appropriate idealisations which are compatible with the objectives of the analysis and simulation being undertaken.
C3 Employ an analysis and simulation system to achieve the objectives of the task set and to validate the results obtained as far as practical.
C4 Demonstrate sound engineering judgement and effective communication skills.

The standards set for each criterion per Module Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessment.

Principles of Assessment and Feedback
(within Assessment and Feedback Policy at: https://www.strath.ac.uk/professionalservices/staff/policies/academic/)

Students are provided with marking schedules which provide an indication of marks assigned and performance required and the marking schedule also provides an indication of the challenges and where effort is best employed.

There are generally 2-4 hours of manned laboratory sessions per week and students who attend have ample opportunity for feedback on progression. In addition, on release of coursework marks, students have the opportunity to seek further feedback. Students therefore have the opportunity to improve over the 2 assessed elements.

The significant laboratory content also provides students with the opportunity to develop and practice the required competences before summative assessment takes place. Two sections of the course involve the application of analysis and simulation software and feedback from one section should lead to improved performance.

The essence of the laboratory element is interaction and dialogue and discussion amongst students is also encouraged and while no formal opportunities for self-assessment exist, students are encouraged to reflect on their development during the laboratory element of the course.

Although there is a variation across the 2 course sections, students are generally engaged in the timing of assessment and also the topic in some cases. Marking schedules are also presented and discussed in some sections. While the assessment regime is laid down in the module descriptor, students are involved in the discussion and weightings of elements of the summative coursework in some sections of the course. Social integration during the learning process is much in evidence during the laboratory sessions.

Additional formative assessment is included during the first semester to engage students with report writing good practices and software competency. These will provide opportunities for agile teaching to provide additional clarification in areas of difficulty identified from these formative assessments.

Staff involved in this subject hold a post-mortem each year and share their own experiences with a view to updating the module and improvement of the student learning experience.

Assessment Method(s) Including Percentage Breakdown and Duration of Exams *(individual weightings)*

Examination				Coursework		Practical		Project	
Number	Month(s)	Duration	***Weighting***	Number	***Weighting***	Number	***Weighting***	Number	***Weighting***
				2	50% each				
*				* LO1 and LO2		*		*	

* ***L/Os:*** *Indicate which Learning Outcomes (L01, L02, etc) are to be assessed by exam/coursework/practical/project as required.*

Coursework / Submissions deadlines (*academic weeks*):
To be notified by class lecturer – week 11 of each semester.

Resit Assessment Procedures:
Submission of alternate ^^coursework prior to the commencement of the July/August exam diet.

^^Students must contact the module Registrar for details as soon as results confirm that a resit is required.

PLEASE NOTE:
Students must gain a summative mark of 40% to pass the module. Students who fail the module at the first attempt will be re-assessed during the July/August exam diet. This re-assessment will consist entirely of coursework. No marks from any previous attempts will be transferred to a new resit attempt.

Recommended Reading

*****Purchase recommended **Highly recommended reading *For reference**

*** ** * "Finite Element Simulations with ANSYS Workbench 2023: Theory, Applications, Case Studies", by Huei-Huang Lee (SDC Publications, 2023), ISBN: 978-1630575397. *Copies in the Main Library and Online:* https://www.sdcpublications.com/Textbooks/Finite-Element-Simulations-ANSYS-Workbench/ISBN/978-1-63057-615-8/

** "Engineering finite element analysis" [internet resource] by R.M. Pidaparti (Springer Nature Switzerland AG, 2022), ISBN 9781627056878. Full online access via the Library website: https://link.springer.com/book/10.1007/978-3-031-79570-1

** "Engineering analysis with ANSYS software" 2nd Edition [internet resource] by T. Stolarski, Y. Nakasone, S. Yoshimoto (Elsevier, Oxford: Butterworth-Heinemann 2018), ISBN: 9780081021644. Full online access via the Library website: https://www.sciencedirect.com/book/9780081021644/

** An Introduction to ANSYS Fluent 2021 by John E. Matsson, SDC Publications, ISBN: 9781630574628

* Numerical Computation of Internal and External Flows: Volume 2: Computational Methods for Inviscid and Viscous Flows by C. Hirsch, John Wiley & Sons, Ltd, ISBN: 978-0-471-92452-4

* Fluids, Materials and Microgravity: Numerical Techniques and insights into Physics by M. Lappa, Elsevier Science (2004, Oxford, England) ISBN 978-0-08-044508-3

* Thermal Convection: Patterns, Evolution and Stability, by M. Lappa, John Wiley & Sons, Ltd (2009, Chichester, England), ISBN 978-0-470-69994-2.

* Rotating Thermal Flows in Natural and Industrial Processes, by M. Lappa, John Wiley & Sons, Ltd, (2012, Chichester, England), ISBN-13: 978-1-1199-6079-9

** It is strongly recommended that students who have not completed 16363 in year three familiarise themselves with notes and learning from this class PRIOR to start of the semester. Notes for FEA shall be made available to students on the 16429 Myplace site.

** ANSYS 2024 R1 or R2 can be downloaded freely (https://www.ansys.com/en-gb/academic/students) and installed on students own Windows PC for self-learning. Students' Windows PC must be capable of running the software, or alternatively a University Windows Virtual Desktop (WVD) remote connection can be used. Please note that selected campus PCs and WVD currently have ANSYS 2024 R1 installed. Model databases created with later revisions than 2023 R1 may not be compatible with on campus installations.

Additional Student Feedback
(Please specify details of when additional feedback will be provided)

Date	Time	Room No
Weekly tutorial	TBC	Check timetable webpages for details

Session: 2024/25

Approved:

Programme Lead/Director Signature: Dr A McLaren & Dr G Houston-Scott
Date of Last Modifications: 02/08/2024

(MAE template updated July 2024)

MODULE TIMETABLE

Module Code:	**16429**	**Module Title:**	**COMPUTER AIDED ENGINEERING DESIGN**

Brief Description of Assessment:

Two major coursework elements in the two distinct areas of the course, equally weighted. Approximate timings of the courseworks are provided below.

Assessment Timing:-

Indicated on the table below are the start/submission dates for each assignment/project and the timing of each exam/assessment.

Please note: Timings could change during unforeseen periods of disruption; this should only be used as a guide.

Semester One	W&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Set	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item.	Course work Submit	Choose an item. Choose an item.

Semester Two	C&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Set	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item.	Course work Submit	Choose an item. Choose an item.