MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

16363 (16366 sem1 / 16367 sem2) ENGINEERING ANALYSIS 3

Module Registrar: Prof Donald Mackenzie d.mackenzie@strath.ac.uk	**Taught To (Course): Cohorts for whom class is compulsory / optional**	
Other Lecturers Involved: **(sem1 FEM/FEA): Prof Mackenzie** **(sem2 CFD): Dr Umer Saleem**	**Credit Weighting: 20 (ECTS 10)**	**Semester: 1 and 2**
Compulsory /optional class	**Academic Level: 3**	**Suitable for Exchange: Y**

Alternative codes and credit values for those taking only one semester:
Semester 1: 16366 Engineering Analysis 3 (Sem 1) [10 Credits / ECTS 5]
Semester 2: 16367 Engineering Analysis 3 (Sem 2) [10 Credits / ECTS 5]

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.

Semester 1	Semester 2
• **Mathematics:** Vectors & matrices; Solution of simultaneous equations; Differentiation and integration; Interpolation • **Mechanics:** Linear elastic, static structural analysis; Engineers Theory of Bending • **CAD Modelling**	**Mathematics:** Differential operators; Partial differential equations; solution of linear systems **Fluid Mechanics:** Navier-Stokes equations; Boundary layer theory; Compressibility effects; Principles of turbulent flows

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

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
20	20	20					20	120	200

Educational Aim

This module aims to introduce the students to the theory and application of the two most widely used numerical methods in engineering analysis: the Structural Finite Element Method and the Finite Difference / Finite Volume methods for fluid mechanics.

Learning Outcomes

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

LO1 Understand the basic theory of the Finite Element Method and Finite Differences/Volumes for fluids;
LO2 Use FEM software ANSYS Workbench and CFD software FLUENT to solve various simplified practical engineering problems;
LO3 Understand how mathematics, numerical analysis and computing technology are combined to model and simulate the behaviour of physical systems.

Syllabus

The module will teach the following:

1st Semester Mathematical modelling of engineering systems using the Finite Element Method: Theory and practice. Introduction to the commercial finite element program ANSYS Workbench; structural analysis; stress analysis.

2nd Semester Partial derivatives and differential equations (PDE); Characteristics and domain of influence; Finite Difference method; Global error and convergence; Local truncation error and consistency; Stability; Conservation equations of fluid dynamics; Mathematical and numerical difficulties; Finite Volume method; Discretization of the domain; Semi-discrete form of the equations; High-resolution methods; Boundary conditions; Introduction to turbulence modelling.

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 Understand energy method, displacement interpolation, element stiffness matrix, global stiffness matrix, boundary conditions, numerical solution procedure;
C2 Understand control volume, differential method and higher order method, recirculation zones/stagnation points, boundary layers;
C3 Understand procedure to solve structure and fluid problems numerically.

LO2

C1 Be able to use commercial FEM software to solve solid and structure problems;
C2 Be able to use commercial CFD software to create models and solve different types of fluid problems;
C3 Be able to obtain important results from commercial software through post processing.

LO3

C1 Understand how to simulate the behaviour of a physical system by transferring the practical problem into a mathematical model and using suitable numerical methods to solve the problem with a computer;
C2 Be able to recognise the types of error in numerical analysis and how to improve the accuracy of results.

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)

Each student may receive advice concerning practical computer analysis workshops through the class forum.
Tutorial questions raised by students will be collated and discussed in the forum.

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

Examination				**Coursework**		**Practical**		**Project**	
Number	Month(s)	Duration	***Weight***	Number	***Weight***	Number	***Weight***	Number	***Weight***
1 1	Dec Apr/May	1 hr 1.5 hr	30% 45%	4 (s1)	20% (5% each)	4 (s2)	5%		
* LO1, LO2, LO3				* LO1		* LO2		*	

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

Coursework / Submission deadlines (*academic weeks*):
Semester 1 Weeks 4, 6, 8, 10.
Semester 2 during the Exam Diet

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

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

PLEASE NOTE:
16366 (Sem1 10 credit module): Marks (totaling 50%) will be scaled to 100%
16367 (Sem2 10 credit module): Marks (totaling 50%) will be scaled to 100%

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 before the August 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" by Huei-Huang Lee, SDC Publications.
** "An introduction to Computational Fluid Dynamics" by H K Versteeg & W Malalasekera, Longman Scientific & Technical, ISBN 0-582-21884-5

Please see Reading List on Myplace for further details.

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

Date	Time	Room No
		Check Myplace for details

Session: 2023/24

Approved:

Course Director Signature:	**S Connolly (on behalf of E Henderson)**
Date of Last Modifications:	**07/09/2023**

(Updated September-2023)

MODULE TIMETABLE

Module Code:	**16363, 16366, 16367**	**Module Title:**	**Engineering Analysis 3**

Brief Description of Assessment:

Semester 1 (16366) is assessed by a 1-hour exam and Untimed Quizzes (Coursework) for the 4 FEA Workshops
Semester 2 (16367) is assessed by a 1.5-hour exam and 4 Practical PC labs for CFD

Assessment Timing

Indicated on the table below are the start/submission dates for each assignment/project and the timing of each exam/assessment. Dropdowns may be left blank. Add extra notes below the dropdowns where relevant.

Please note: Timings can and will change, 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.	Course work Set	Choose an item. Choose an item.	Course work Submit Course work Set	Choose an item. Choose an item.	Course work Submit Course work Set	Choose an item. Choose an item.	Course work Submit Course work Set	Choose an item. Choose an item.	Course work Submit	Choose an item. Choose an item.	Exam

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.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Lab	Lab	Lab	Lab	Choose an item. Choose an item.	Exam Lab Report Submission