MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

ME945 Introduction to Open Source Computational Fluid Dynamics

Module Registrar: Dr Umer Saleem umer.saleem@strath.ac.uk	**Taught To (Course): MSc AME Online**	
Other Lecturers Involved:	**Credit Weighting: 10**	**Semester: 2 (Online Learning)**
Optional	**Academic Level: 5**	**Suitable for Exchange: N**

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

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
					36		24	40	100

Educational Aim

This module is intended for MSc students who have either no prior experience of computational fluid dynamics (CFD) or students who only have experience of using commercial CFD codes and would like to investigate an open source CFD code that is used predominantly for research. It aims to introduce the principles and application of numerical simulation of fluid flows and to underpin the theoretical foundations by applying a CFD code to realistic flow problems.

Learning Outcomes

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

LO1 Understand the governing flow equations for common flow problems and to understand why discretisation of a domain into a mesh is required.

LO2 Understand why boundary conditions need to be applied.

LO3 Understand numerical solution methods and their limitations and to understand the role of turbulence, its influence on fluid flows and how it is modelled in RANS codes.

LO4 Construct a case for the simulation of an incompressible, steady state, fluid flow.

Syllabus

The module will teach the following:

What the terms in the Navier Stokes equations represent and how they are discretised in order to allow them to be solved by the finite volume technique. Why boundary conditions are required and how they are applied in the FV solution. The necessity to use closure schemes in the form of turbulence models to allow the RANS to be solved. When the fundamentals of CFD analysis are understood the students will be required to undertake the simulation of a limited number of steady-state, incompressible, flow processes. At the end of the course the student should be able to analyse simple flow problems using on open source CFD code.

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 Be able to understand governing flow equations, theory related to partial differential equations
C2 Be able to understand the vector mathematics, continuity, momentum and Navier-Stokes Equations
C3 Be able to understand the Spatial & Temporal discretisation and pressure velocity coupling
C4 The ability to mesh a domain

LO2
C1 Be able to understand the theory related to boundary conditions
C2 The ability to apply the correct boundary conditions

LO3
C1 The ability to apply numerical solution method for the designated physical problem and understand limitations
C2 The ability to choose the right turbulence model and how it is modelled in RANS codes

LO4
C1 Be able to construct the incompressible and steady fluid flow model on open source tool (e.g. OpenFOAM)
C2 The ability to simulate a flow and analyse the 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/)

Assessment will be by online time constrained quizzes to assess progress, and submission of one (1) coursework containing the results of the CFD simulation and verification.

Regular feedback and discussion will be available in online tutorial sessions using a MyPlace online discussion forum. Feedback from the report will enable students to reflect on their understanding of the subject material. Individual feedback will be available by appointment with the course lecturers. Report submission will be returned with marks and detailed written feedback to allow students to reflect on their performance.

Discussion of the course material between lecturer-student and amongst peers will be encouraged by participation in online forums.

Summative feedback: The summative feedback will be provided by the assessment results of the online quizzes and the report.

Formative feedback: Online forums will provide opportunities for students to discuss their work and course material with staff and other students.

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

Online Assessment				**Coursework**		**Practical**		**Project**	
Number	Month(s)	Duration	***Weighting***	Number	***Weighting***	Number	***Weighting***	Number	***Weighting***
7 online	See below		40%	1	60%				
* LO1-3				* LO4		*		*	

* ***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*):

All online time constrained quizzes must be completed by the end of semester 2 week 11. The coursework is to be submitted by 12 noon on the Thursday of the last week of the semester 2 exam diet (dates confirmed in the University Calendar).

Resit Assessment Procedures:
New set of time constrained quizzes and alternate coursework to be submitted by 12 noon on the Thursday prior to commencement of the August exam diet (the date for which is confirmed in the University Calendar).

As soon as a student knows that they require a resit assessment for this class they should contact the class registrar to confirm these resit requirements and deadlines for this class.

PLEASE NOTE:
Students must gain a summative mark of 50% 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 of additional submission as outlined above. No marks from any previous attempts will be transferred to a new resit attempt.

Recommended Reading

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

Computational Fluid Dynamics for Engineers, Anderson et al, Cambridge. ISBN 978110701895-2***
Computation Fluid Dynamics – A practical approach, Tu et al Butterworth Heinemann ISBN 978008098243-4***

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

Date	Time	Room No
		Check timetable webpages for details

Session: 2023/24

Approved:

Course Director Signature:	**Olga Ganilova**
Date of Last Modifications:	**17/01/24**

(form Updated January 2024)

MODULE TIMETABLE

Module Code:	**ME945**	**Module Title:**	**Introduction to Open Source Computational Fluid Dynamics**

Brief Description of Assessment:

Online time constrained quizzes which must be re-taken until 90% or higher successful completion is achieved. Each quiz is of approximately 60 minutes duration and subsequent quizzes will be accessible only after the 90% mark has been reached. The final grade will be calculated considering the mark obtained with the first attempt of each new quiz.
1 coursework.

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.	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.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. 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.	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.	Choose an item. Choose an item.	Online Test: All quizzes to be completed	Coursework to be submitted by 12:00 on last Thursday of exam period