Module Code	MEP55E04
Module Name	Computational Fluid Mechanics
ECTS Weighting[1]	5 ECTS
Semester taught	Semester 1
Module Coordinator/s	Associate Professor Séamus O'Shaughnessy
Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline.	On successful completion of this module, students should be able to: 1. Systematically apply conservation equations to common computational fluid dynamics (CFD) engineering applications. 2. Be able to critically evaluate the correct boundary/initial conditions for various problems. 3. Understand the requirements of computational grid/mesh generation for CFD applications. 4. Gain hands-on user experience with well-known CFD software packages. 5. Analyse different numerical techniques used to enhance the quality of the simulations. 6. Undertake complete fluid flow and heat transfer simulations using CFD. 7. Demonstrate a critical awareness of the concepts of stability, approximation, and convergence. 8. Implement comprehensive post-processing of numerical simulation results. 9. Assess numerical results both quantitatively and qualitatively to improve accuracy. **Graduate Attributes: levels of attainment** To act responsibly - Enhanced To think independently - Enhanced To develop continuously - Enhanced To communicate effectively - Enhanced
Module Content	Computational Fluid Dynamics (CFD) is the art of replacing governing partial differential equations (PDE) systems with a set of algebraic equations which can be solved using digital computers to analyse problems that involve fluid flows. CFD is a fluid mechanics tool that is frequently used to provide practical and insightful simulations of real-life problems using numerical methods and algorithms. CFD is wide-ranging in its application and is regularly employed across engineering industry in areas such as aerospace, architecture, automotive, civil engineering, manufacturing, process industry, turbo-machinery and wastewater treatment. The ultimate goal of the CFD simulation is to discover and evaluate the flow phenomena that occur in various existing real-life examples and new engineering systems.

[1] TEP Glossary

Teaching and Learning Methods	MEP55E04 Computational Fluid Mechanics is an optional module which is offered to 5th year MAI students, M.Sc. in Mechanical Engineering students and PhD students. This module equips students to apply CFD methods as a tool for design, analysis, and engineering applications such as fluid flow and heat transfer. The module material is presented in a series of lecture notes intended for self-directed learning, and/or narrated videos of CFD exercises. Students are therefore expected to conduct a significant amount of self-directed learning for this module. The core teaching material is supplemented by weekly 2-hour or 3-hour CFD laboratory sessions during which the students will apply the information provided to CFD simulations using existing College-licenced commercial CFD software package(s), which may be supplemented with basic programming exercises in Microsoft Excel and/or MATLAB. CFD laboratory sessions are also used for Q&A regarding module content. Online quizzes and assignments reinforce engagement with the module material. With a strong emphasis on understanding and application of the underlying methods, enthusiastic students will gain experience using commercial CFD software packages by analysing well established CFD problems as well as applying their knowledge to current research projects within the School of Engineering.
Student Software	ANSYS offer a free student version of their software which is available at the link below. The version will be specified by the module coordinator. Please note the software limitations and hardware requirements listed on the webpage. Also note that this software is not backwards compatible, so you will not be able to open files created in the latest student version on earlier versions. In the event of limited access to the university and computer facilities, remote desktop access will be organised for students (https://www.ansys.com/academic/free-student-products).
Accessibility	MEP55E04 involves significant interaction with Windows-based PC software such as MS Excel. MATLAB and ANSYS, as well as online learning platforms such as Blackboard. All CFD laboratory sessions take place either in the Parsons Building TCD, and/or online. Students can choose to use their own hardware. Remote access will be provided in the event of limited access to the University. Students enrolled in this module who experience disAbilities are encouraged to confidentially contact the module coordinator to ensure that the content is delivered in an appropriate manner.

Assessment Details[2]
Please include the following:

- **Assessment Component**
- **Assessment description**
- **Learning Outcome(s) addressed**
- **% of total**
- **Assessment due date**

Assessment Component	Assessment Description	LO Addressed	% of total	Week due
Test 1	Blackboard quiz	1-3	15	3 or 4
Assignment 1	Report/presentation of CFD study	1-9	20	7 or 8
Test 2	Blackboard quiz	1-3	15	6 or 7
Test 3	Blackboard quiz	1-3	15	9 or 10
Assignment 2	Report/presentation of CFD study	1-9	35	12

Reassessment Requirements

Students who require re-assessment will be obliged to conduct a significant CFD case study during a period after the end of semester 2.

Contact Hours and Indicative Student Workload[2]

Contact hours: 44
Preparation for module and review of materials: 35
Preparation for assessment, incl. completion of assessment: 46

Recommended Reading List

- Numerical Heat Transfer and Fluid Flow – Suhas V. Patankar
- CFD The basics with applications – John D. Anderson Jr.
- An Introduction to CFD – H.K. Versteeg & W Malalasekera

Module Pre-requisite

Foundation modules in Numerical Methods, Fluid Mechanics (*e.g.*, MEU33B02, MEU44B13), and Heat Transfer (*e.g.*, MEU44B04)

Module Co-requisite

n/a

Module Website

See Blackboard

Are other Schools/Departments involved in the delivery of this module?

No

Module Approval Date

Approved by

Academic Start Year

2017

Academic Year of Date

2025-26

[2] TEP Guidelines on Workload and Assessment