Module Template for New and Revised Modules[1]

Module Code	ME5E04
Module Name	Introduction to Computational Fluid Dynamics
ECTS Weighting[2]	5 ECTS
Semester taught	Semester 1
Module Coordinator/s	Ussher Assistant 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 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

[1] An Introduction to Module Design from AISHE provides a great deal of information on designing and re-designing modules.
[2] TEP Glossary

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.
Teaching and Learning Methods	ME5E04 Introduction to CFD is an optional course which is offered to 5th year MAI students and equips students to apply CFD methods as a tool for design, analysis and engineering applications such as fluid flow and heat transfer. The course material is presented in a series of online or face-to-face lectures and/or narrated videos of CFD exercises. Students are expected to conduct a significant amount of self-directed learning for this module. The core teaching material is supplemented by weekly laboratory sessions during which the students will apply the information provided during lectures to CFD simulations using existing College-licenced commercial CFD software package(s), which may be supplemented with basic programming exercises in Microsoft Excel or Matlab. 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. 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	5E04 involves significant interaction with Windows-based PC software such as Matlab and ANSYS, as well as online learning platforms such as Blackboard. All laboratory sessions take place either in the Parsons Building TCD or online. Students can choose to use their own hardware, or remote access will be provided in the even o 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[3]
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
Assignment 1	CFD study and associated report or presentation	3-9	20	4
Online test 1	Online Quiz via Blackboard	1-3	12.5	6
Assignment 2	CFD study and associated report or presentation	3-9	25	8
Online test 2	Online Quiz via Blackboard	1-3	12.5	10
Assignment 3	CFD study and associated report or presentation	3-9	30	12

Reassessment Requirements

Since this module is entirely evaluated using continuous assessment during the 1st semester, students who require re-assessment will be obliged to conduct a significant number of CFD case studies as well as the online tests during a period after the end of semester 2.

Contact Hours and Indicative Student Workload[3]

Contact hours: 44
Preparation for course and review of materials: 40
Preparation for assessment, incl. completion of assessment: 40

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
- CFD, Volume 1, 4th Edition – Klaus A. Hoffman, Steve T. Chang

Module Pre-requisite

Foundation courses in Numerical Methods (e.g. 2E11/3E2), Fluid Mechanics (e.g. 3B02, 4B13), and Heat Transfer (e.g. 4B04)

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

[3] TEP Guidelines on Workload and Assessment

Academic Year of Date	2020