Module Descriptor

Title	Advanced Fluid Mechanics and CFD		
Session	2025/26	**Status**	Published
Code	ENGG11033	**SCQF Level**	11
Credit Points	20	**ECTS (European Credit Transfer Scheme)**	10
School	**Computing, Engineering and Physical Sciences**		
Module Co-ordinator	L Sun		

Summary of Module

The module starts with a review of the principles of fluid mechanics and its application to engineering problems, then discusses CFD and numerical techniques, turbulence, compressible flow, non-Newtonian flow, multiphase systems, flow in porous media, etc.

After a review of the equations of motions, turbulence and boundary/wall treatment, Computational Fluid Dynamics (CFD) and turbulence modelling are discussed. The module discusses solution techniques and other issues related to CFD such as errors, uncertainty, validation, mesh quality, convergence, etc.

Both 1-dimensional and 2-dimensional compressible flows will be covered as well as steady and unsteady flows. This includes solution methods including numerical ones, and gas movers as the implications of compressible flow.

Models for stress-strain relations in non-Newtonian fluids and their applications to different flow situations will be covered. This also includes the implications for equipment in the presence of non-Newtonian behaviour.

The module deals with multiphase flows and issues such as classification of multiphase flows, flow regimes, interfacial interactions and transfer, flow hydrodynamics, instability, and modelling of multiphase systems will be covered. The course will deal with gas-liquid, solid-liquid, solid-gas and liquid-liquid systems.

Theoretical and practical fundamentals of measurements in flow systems will be discussed.

The module will be illustrated with relevant engineering examples.

The module will develop students' ability to apply the knowledge of the principles of widely used unit operations to solve complex process problems.

• I am UWS (https://www.uws.ac.uk/current-students/your-graduate-attributes/): Upon completing this module the students will be equipped with tools that will help them in their journey to be work-ready, successful and universal. The module develops critical thinking and analytical skills that enhance the students' ability to deal with complicated issues and make them problem solvers. It encourages them to become motivated, innovative, autonomous, inquisitive, creative and imaginative. The module and the teaching approach encourage collaborative working, effective communications, resilience and perseverance, and development of research and inquiry skills. The aim is to produce graduates who are knowledgeable with excellent digital skills fit for the 21st century and aware of the global context in which they operate and the challenges that face humanity in the 21st century in the areas of water, food, energy, environment and well-being, who strive to lead, influence and dare to make transformational changes while being ethically-minded, socially responsible,

critically aware of the environmental and social impacts of their decisions and actions, and culturally sensitive.

Module Delivery Method	**On-Campus[1]** ☒	**Hybrid[2]** ☐	**Online[3]** ☐	**Work -Based Learning[4]** ☐
Campuses for Module Delivery	☐ Ayr ☐ Dumfries	☐ Lanarkshire ☐ London ☒ Paisley	☐ Online / Distance Learning ☐ Other (specify)	

Terms for Module Delivery	Term 1	☒	Term 2	☐	Term 3	☐
Long-thin Delivery over more than one Term	Term 1 – Term 2	☐	Term 2 – Term 3	☐	Term 3 – Term 1	☐

Learning Outcomes	
L1	Develop a critical understanding of advanced concepts of fluid mechanics that covers both depth and breadth of the subject.
L2	Develop advanced and critical knowledge of the role played by fluid mechanics in the design and analysis of fluid dynamic systems.
L3	Develop the underlying knowledge that will enable the design and analysis of systems even in the cases of missing and incomplete data through research and innovation.
L4	Develop the advanced skill required to use modern tools such as CFD in the design of engineering systems with critical understanding of their scope and limitations.
L5	Develop the knowledge to select and adapt computational and analytical techniques to tackle complex problems.

Employability Skills and Personal Development Planning (PDP) Skills	
SCQF Headings	**During completion of this module, there will be an opportunity to achieve core skills in:**
Knowledge and Understanding (K and U)	**SCQF 11** Demonstrate:

[1] Where contact hours are synchronous/ live and take place fully on campus. Campus-based learning is focused on providing an interactive learning experience supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus contact hours will be clearly articulated to students.

[2] The module includes a combination of synchronous/ live on-campus and online learning events. These will be supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus and online contact hours will be clearly articulated to students.

[3] Where all learning is solely delivered by web-based or internet-based technologies and the participants can engage in all learning activities through these means. All required contact hours will be clearly articulated to students.

[4] Learning activities where the main location for the learning experience is in the workplace. All required contact hours, whether online or on campus, will be clearly articulated to students

	• A critical knowledge that covers and integrates most of the main areas of the discipline of fluid mechanics and their relevance and application in engineering context and at advance level. • A critical understanding of the principal theories, concepts and principles of advanced fluid mechanics. • A critical understanding of a range of specialised theories, concepts and principles applied to fluid mechanics. • Extensive, detailed and critical knowledge and understanding of the role of fluid mechanics in engineering applications as well as in other areas such as the environment and biology. • Develop a critical understanding of the implication of knowledge of fluid mechanics principles in the advancement of modern and innovative engineering design, conservation of resources and sustainability.
Practice: Applied Knowledge and Understanding	**SCQF 11** • Use a significant range of the core engineering knowledge and skills to advance the knowledge of fluid mechanics and its application in engineering context. • The ability to use a range of specialised skills, techniques, practices and/or materials that are informed by the recent advances in the field of fluid mechanics. • Apply a range of standard and specialised research and other techniques to advance understanding of fluid mechanics. • Plan, develop and execute a relevant design based on advanced knowledge, research and innovation. • Demonstrate originality, creativity and critical thinking. • Apply knowledge of fluid mechanics in a wide variety of engineering applications that demand innovation. • Select and apply appropriate computational and analytical techniques to model complex problems, discussing the limitations of the techniques employed. • Select and critically evaluate technical literature and other sources of information to solve complex problems.
Generic Cognitive skills	**SCQF 11** • Apply critical analysis, evaluation and synthesis to forefront issues, or issues that are informed by forefront developments in the area of fluid mechanics and the interaction with the engineering aspects of the profession. • Practice at a high level the ability to critically identify, analyse, conceptualise and define new and abstract problems related to fluid mechanics and the application of the concepts in engineering context. • Develop and demonstrate original and creative thinking and responses in dealing with complex or novel problems and issues. • Critically review, consolidate and extend knowledge, skills, practices and thinking in the field of fluid mechanics. • Deal with complex issues and make informed judgements in situations in the absence of complete or consistent data/information through innovation and research.

Communication, ICT and Numeracy Skills	**SCQF 11** • Communicate, using appropriate methods, to a range of audiences with different levels of knowledge/expertise. • Communicate with peers, more senior colleagues and specialists. • Use a wide range of ICT applications to support and enhance work at this level and show critical understanding of the scope and limitations of the tools used and their underlying theoretical basis. • Undertake critical evaluations of a wide range of numerical and graphical data with the ability to deal with situations involving missing data and lack of information using research.
Autonomy, Accountability and Working with Others	**SCQF 11** • Exercise high level of autonomy and initiative in professional and equivalent activities with the ability to work independently on significant and demanding tasks. • Take responsibility for own work and/or significant responsibility for the work of others providing leadership. • Take responsibility for a significant range of resources. • Demonstrate leadership and/or initiative and make an identifiable contribution to change and development • Practise in ways which draw on critical reflection on own and others' roles and responsibilities. • Deal with complex ethical and professional issues in engineering context and make informed judgements on issues not addressed by current professional and/or ethical codes or practices.

Prerequisites	**Module Code**	**Module Title**
	Other	
Co-requisites	**Module Code**	**Module Title**

Learning and Teaching	
In line with current learning and teaching principles, a 20-credit module includes 200 learning hours, normally including a minimum of 36 contact hours and maximum of 48 contact hours. This module covers a wide variety of theoretical, conceptual and practical areas, which require a range of knowledge and skills at a more advanced level to be displayed and exercised. Delivery of its syllabus content therefore involves a diversity of teaching and assessment methods suitable to the learning outcomes of the module; these include formal lectures, structured tutorials, open ended problem solving, flipped class teaching directly related to assessment tasks, practical exercises in calculation and modelling linked to analysis of equipment performance, completion and submission of written coursework making use of appropriate forms of IT and VLE, and independent study.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Note: Learning hours include both contact hours and hours spent on other learning activities)

Lecture / Core Content Delivery	24
Tutorial / Synchronous Support Activity	12
Laboratory / Practical Demonstration / Workshop	12
Independent Study	152
n/a	0
n/a	0
TOTAL	200

Indicative Resources

The following materials form essential underpinning for the module content and ultimately for the learning outcomes:

Oosthuizen, P. H. and Carscallen W. E. (2014) Introduction to Compressible Fluid Flow. 2nd Edition. Boca Raton, Fla.; London: CRC Press

Chhabra, R.P. and Richardson J. F. (2008) Non-Newtonian Flow and Applied Rheology: Engineering Applications. 2nd Edition. Burlington: Elsevier

Anderson, J. (1995) Computational Fluid Dynamics: The Basics with Applications. McGraw Hill

Tu, J. Yeoh, GH., and Liu, C. (2018) Computational Fluid Dynamics: A Practical Approach. 3rd Edition. Amsterdam : Butterworth-Heinemann

Yadigaroglu, G.(editor), Geoffrey, Hewitt, G. F. (editor) (2018) Introduction to Multiphase Flow Basic Concepts, Applications and Modelling. Cham, Switzerland: Springer

(N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

Attendance and Engagement Requirements

In line with the Student Attendance and Engagement Procedure, Students are academically engaged if they are regularly attending and participating in timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time.

For the purposes of this module, academic engagement equates to the following:

The School of Computing, Engineering and Physical Sciences considers attendance and engagement to mean a commitment to attending, and engaging in, timetabled sessions. You will scan your attendance via the scanners each time you are on-campus and you will login to the VLE several times per week. Where you are unable to attend a timetabled learning session due to illness or other circumstance, you should notify the Programme Leader that you cannot attend. Across the School an 80% attendance threshold is set. If you fall below this, you will be referred to the Student Success Team to see how we can best support your studies.

Equality and Diversity

The University's Equality, Diversity and Human Rights Procedure can be accessed at the following link: UWS Equality, Diversity and Human Rights Code.

Aligned with the University's commitment to equality and diversity, this module supports equality of opportunity for students from all backgrounds and learning needs. Using the VLE, material will be presented electronically in formats that allow flexible access and

manipulation of content. This module complies with University regulations and guidance on inclusive learning and teaching practice. This module has lab-based teaching and as such you are advised to speak to the Module Co-ordinator to ensure that specialist assistive equipment, support provision and adjustment to assessment practice can be put in place, in accordance with the University's policies and regulations.
(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)

Supplemental Information

Divisional Programme Board	**Engineering Physical Sciences**
Overall Assessment Results	☐ **Pass / Fail** ☒ **Graded**
Module Eligible for Compensation	☐ **Yes** ☒ **No** **If this module is eligible for compensation, there may be cases where compensation is not permitted due to programme accreditation requirements. Please check the associated programme specification for details.**
School Assessment Board	Design
Moderator	A Durrant
External Examiner	P Weston
Accreditation Details	IMechE as part of MEng (Hons) Menchanical Engineering
Module Appears in CPD catalogue	☐ **Yes** ☒ **No**
Changes / Version Number	2.04 External Examiner updated- Peter Weston Accreditation updated- Pending accreditation Attendance and Engagement Requirement updated Equality and Diversity updated

Assessment (also refer to Assessment Outcomes Grids below)
Assessment 1
Final exam worth 70% of the final mark
Assessment 2
Course works worth 30% that include CFD and design problems.
Assessment 3
(N.B. (i) Assessment Outcomes Grids for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An indicative schedule listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Module Handbook.)

Component 1

Assessment Type	LO1	LO2	LO3	LO4	LO5	Weighting of Assessment Element (%)	Timetabled Contact Hours
Unseen open book	☒	☒	☐	☐	☐	70	3

Component 2							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Design/ Diagram/ Drawing/ Photograph/ Sketch	☐	☐	☒	☒	☒	30	0

Component 3							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
	☐	☐	☐	☐	☐		
Combined total for all components						100%	3 hours

Change Control

What	When	Who
External Examiner updated- Peter Weston Accreditation updated- Pending accreditation Attendance and Engagement Requirement updated Equality and Diversity updated	March 2025	M Mirzaeian