University of the West of Scotland

Module Descriptor

Session: 2024/25

Title of Module: Advanced Reactor Design			
Code: ENGG11036	**SCQF Level: 11 (Scottish Credit and Qualifications Framework)**	**Credit Points: 20**	**ECTS: (European Credit Transfer Scheme) 10**
School:	School of Computing, Engineering and Physical Sciences		
Module Co-ordinator:	Cristina Rodriguez		

Summary of Module

This module provides in-depth coverage of the safe and sustainable design of multiphase and biochemical reactors as well as the associated heat and thermal issues. The module revises chemical reactor fundamentals and reaction kinetics, then covers the design techniques of several types of industrially important reactors and related issues such as kinetics for multiphase reactors, transient behaviour, deviation from ideal behaviour and residence time distribution models, multiple steady states, stability, selectivity, sustainability and safety in the design of chemical and biochemical reactors.

The module discusses the modelling and design of Non-Catalytic Multiphase Reactors (mass transfer with chemical reactions, hydrodynamics of multiphase reactors, packed columns, plate columns, stirred tank reactors, bubble columns),Biochemical Reactors (operation in suspension and immobilized systems). Special attention will be paid to non-ideality in chemical reactors with mathematical treatment of residence time distribution in real reactors.

All students carry out and optimise a design on an assigned reactor to include materials of construction, its integration with other processes, the classification of hazardous areas, the procedure of its construction and decommission and of its control and dynamic behaviour in the face of various likely disturbances. In this design, students will familiarize themselves with the principles of sustainability, ethics, economy of process and the unknown.

Module Delivery Method

Face-To-Face	**Blended**	**Fully Online**	**HybridC**	**Hybrid 0**	**Work-Based Learning**
☒	☐	☐	☐	☐	☐

See Guidance Note for details.

Campus(es) for Module Delivery						
The module will **normally** be offered on the following campuses / or by Distance/Online Learning: (Provided viable student numbers permit) (tick as appropriate)						
Paisley:	Ayr:	Dumfries:	Lanarkshire:	London:	Distance/Online Learning:	Other:
☒	☐	☐	☐	☐	☐	Add name

Term(s) for Module Delivery					
(Provided viable student numbers permit).					
Term 1	☐	Term 2	☒	Term 3	☐

Learning Outcomes: (maximum of 5 statements) **These should take cognisance of the SCQF level descriptors and be at the appropriate level for the module.** At the end of this module the student will be able to:	
L1	Develop a critical understanding of advanced concepts of reactors, including multiphase and biochemical reactors design.
L2	Develop advanced and critical knowledge of the role played by reactors and the heat transfer effects in the chemical process industry.
L3	Develop advanced skills and competences required for the design and analysis of multiphase and biochemical reactors that will also take into consideration issues such as safety, environmental protection, resources conservation and sustainability.
L4	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.
L5	Plan, develop and execute a relevant design based on advanced knowledge, research and innovation within a wide and often changeable variety of economic, legal and environmental constraints in the field of chemical and process engineering.

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 Level **11** Demonstrate: • A Critical knowledge that covers and integrates most of relevant science and technology related to the design multiphase and biochemical reactors and their relevance and application in a chemical process context and at advance level.

	• A critical understanding of the principal theories, concepts and principles of advanced multiphase and biochemical reactors design. • A critical understanding of a range of specialised theories, concepts and principles applied to multiphase and biochemical reactors design. • Extensive, detailed and critical knowledge and understanding of the role of multiphase and biochemical reactors design in an integrated chemical process as in other areas such as the environment and resources minimisation. Develop a critical understanding of the implication of knowledge of multiphase and biochemical reactors design principles in the advancement of modern and innovative chemical processes design, conservation of resources and sustainability.
Practice: Applied Knowledge and Understanding	SCQF Level **11** • Use a significant range of the core chemical reactor engineering knowledge and skills to advance the knowledge of multiphase and biochemical reactors design and its application in chemical process context. • Develop the ability to use a range of specialised skills, techniques, practices and/or materials that are informed by the recent advances in the fields of multiphase and biochemical reactors design. • Apply a range of standard and specialised research and other techniques to advance the understanding of multiphase and biochemical reactors design. • Plan, develop and execute a relevant design based on advanced knowledge, research and innovation. • Demonstrate originality, creativity and critical thinking. • Apply knowledge of multiphase and biochemical reactors design in a wide variety of chemical process applications that demand innovation.
Generic Cognitive skills	SCQF Level **11** • Apply critical analysis, evaluation and synthesis to forefront issues, or issues that are informed by forefront developments in the area of multiphase and biochemical reactors design and the interaction with the other aspects of chemical process design. • Practice at a high level the ability to critically identify, analyse, conceptualise and define new and abstract problems related to multiphase and biochemical reactors design and the application of the concepts in a chemical engineering context. • Develop and demonstrate original and creative thinking and responses in dealing with complex or novel problems and issues related to the design of multiphase and biochemical reactors. • Critically review, consolidate and extend knowledge, skills, practices and thinking in the field of multiphase and biochemical reactors design. • Deal with complex issues and make informed judgements in situations where there is absence of complete or consistent data/information through innovation and research.
Communication, ICT and Numeracy Skills	SCQF Level **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 Level **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.

Pre-requisites:	Before undertaking this module the student should have undertaken the following:	
	Module Code:	**Module Title:**
	Other:	Before undertaking this module, the student should have knowledge on reaction kinetics, mass and energy balances and reactor design.
Co-requisites	**Module Code:**	**Module Title:**

*Indicates that module descriptor is not published.

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.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Normally totalling 200 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
Independent Study	164
	200 Hours Total

****Indicative Resources: (eg. Core text, journals, internet access)**
The following materials form essential underpinning for the module content and ultimately for the learning outcomes: Fogler, H. S. (2016) Elements of Chemical Reaction Engineering. 5th Edition. Prentice Hall. Froment, G. F. and K. B. Bischoff (2011) Chemical Reactor Analysis and Design. 3rd Edition. Hoboken, N.J.: Wiley. Hill, C. G. and T W Root (2014) Introduction to Chemical Engineering Kinetics and Reactor Design. 2nd Edition. Hoboken, N.J : John Wiley. Luyben, William L. (2007) Chemical Reactor Design and Control. Hoboken, N.J.: Wiley-Interscience. Shuler, M. L. and Kargi, F. (2002) Bioprocess Engineering. Basic Concepts. Prentice Hall.
(**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.

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.
(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
Assessment Results (Pass/Fail)	Yes ☐No ☒
School Assessment Board	Engineering

Moderator	Li Sun
External Examiner	R. Ocone
Accreditation Details	This module is part of the BEng(Hons) Chemical Engineering programme accredited by the IChemE.
Changes/Version Number	4.0 Updated module summary. 4.1 Updated Module Delivery Method to Face-to-Face

Assessment: (also refer to Assessment Outcomes Grids below)
Assessment for the module includes both formative and summative assessment. Formative assessment is provided during lectures in the form of class quizzes and exercise problems, during tutorial sessions, and as part of the preparation for written submissions. Summative assessment is provided by written assessment elements as well as a final exam.
Assessment 1 – Final class test worth 50% of the final mark.
Assessment 2 – Presentation worth 10% of the final mark.
Assessment 3 - Design report worth 40% of the final mark.
(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.)

Assessment Outcome Grids (See Guidance Note)

Component 1							
Assessment Type (Footnote B.)	**Learning Outcome (1)**	**Learning Outcome (2)**	**Learning Outcome (3)**	**Learning Outcome (4)**	**Learning Outcome (5)**	**Weighting (%) of Assessment Element**	**Timetabled Contact Hours**
Unseen open book	X	X				50	3

Component 2							
Assessment Type (Footnote B.)	**Learning Outcome (1)**	**Learning Outcome (2)**	**Learning Outcome (3)**	**Learning Outcome (4)**	**Learning Outcome (5)**	**Weighting (%) of Assessment Element**	**Timetabled Contact Hours**
Design Report				X	X	40	0
Presentation		X	X			10	1
Combined Total for All Components						**100%**	**4 hours**