University of the West of Scotland

Module Descriptor

Session: 2024/25

Title of Module: Process Design, Sustainability and Safety			
Code: ENGG11037	**SCQF Level: 11** (Scottish Credit and Qualifications Framework)	**Credit Points: 20**	**ECTS: 10** (European Credit Transfer Scheme)
School:	School of Computing, Engineering and Physical Sciences		
Module Co-ordinator:	Li Sun		

Summary of Module

The focus of the module is the safe design of chemical processes to ensure green and sustainable approach to the design and operation of chemical plants. This requires a multi-disciplinary approach to the design process that is informed by engineering, safety, environmental, economic and societal constraints.

The module reviews the fundamentals of chemical process design including process flowsheeting, process synthesis heuristics, design data, design standards, economic constraints, environmental considerations, and the ethical responsibility of the design engineer towards the society and the environment both locally and globally.

The module covers modern tools used to enhance process safety, improve product quality, and reduce waste generation and resources usage, and develop innovative approaches and the understanding of how to combine and apply different principles such as sustainability, economics, and safety to novel and complex situations with cultural, societal, environmental and commercials considerations.

Process Integration and Synthesis: Pinch analysis techniques, mass targeting; resources, energy and waste minimisation; recycle network and mass exchange network design, and sustainable process design.

Process Intensification: Principles and applications, miniaturisation and micro-processing, mechanisms involved in process intensifications, intensification of reactors, heat exchangers, mixers, and separation processes.

Inherently Safer Process Design: ISD concepts and fundamentals, techniques for ISD implementation and applications to wider engineering disciplines.

Safety Management Systems (SMS): Management of safety during change. Investigation of chemical process incidents. Human errors.

Computer aided process design, analysis and optimisation for sustainable process design. Topics such as process optimisation are also discussed.

- 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					
Face-To-Face	**Blended**	**Fully Online**	**HybridC**	**HybridO**	**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)						
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 knowledge of understanding advanced safe and sustainable process design technologies, and the evaluation of the environmental and societal impact of solutions to complex problems.
L2	Develop advanced and critical knowledge of the role played by Process Design and Safety principles in the design and analysis of systems that will also take into consideration issues such as economics, environmental protection, resources conservation and sustainability.
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 with financial and other risks considerations.
L4	Develop the advanced skill required to use modern tools in the design of engineering systems with critical understanding of their scope and limitations.

L5	Develop critical understanding and a broad knowledge of emerging design and safety technologies and their fit for purpose and limitations, and be able to communicate it to a variety of audiences.

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 the main areas of the discipline of Process Design,sustainability and Safety and their relevance and application in chemical engineering context and at advance level. • A critical understanding of the principal theories, concepts and principles of advanced Process Design,sustainability and Safety. • A critical understanding of a range of specialised theories, concepts and principles applied to Process Design,sustainability and Safety. • Extensive, detailed and critical knowledge and understanding of the role of Process Design,sustainability and Safety in engineering applications as well as in other areas such as the environment.. • Develop a critical understanding of the implication of knowledge of Process Design,sustainability and Safety principles in the advancement of modern and innovative chemical process design, conservation of resources and sustainability.
Practice: Applied Knowledge and Understanding	SCQF Level 11. • Use a significant range of the core engineering knowledge and skills to advance the knowledge of Process Design,sustainability and Safety 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 chemical process field in general and in Process Design,sustainability and Safety in particular. • Apply a range of standard and specialised research and other techniques to advance the understanding and proper utilisation of Process Design,sustainability and Safety fundamentals. • Plan, develop and execute a chemical process design based on advanced knowledge, research and innovation. • Demonstrate originality, creativity and critical thinking. • Apply knowledge of Process Design,sustainability and Safety in a wide variety of chemical engineering 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 Process Design,sustainability and Safety 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 Process Design,sustainability and Safety and the application of the concepts in chemical 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 Process Design,sustainability and Safety. • Deal with complex issues and make informed judgements in

	situations involving the 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. vCommunicate 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:	
Co-requisites	**Module Code:**	**Module Title:**

* Indicates that module descriptor is not published.

Learning and Teaching	
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 the 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** (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:

Crowl, D. A. and Louvar J. F. (2019) Chemical Process Safety: Fundamentals with Applications. 4nd Edition, Boston, Mass.; London: Prentice Hall.

Reay, D. A., Ramshaw C.and Harvey A. (2013) Process Intensification: Engineering for Efficiency, Sustainability and Flexibility. 2nd Edition, Oxford: Butterworth-Heinemann.

El-Halwagi, M. (2017) Sustainable Design through Process Integration : Fundamentals and Applications to Industrial Pollution Prevention, Resource Conservation, and Profitability Enhancement. 2nd Edition, Amsterdam : Elsevier.

Seider, W. D., Lewin D. R., Seader J. D., Widagdo S., Gani R., and Ming NG K.A. NG. (2019) Product & Process Design Principles: Synthesis, Analysis and Evaluation. N.J.: Wiley.

Kletz, T. and Amyotte P. (2010) Process Plants: A Handbook for Inherently Safer Design. 2nd Edition, Boca Raton, Fla.; London: CRC Press.

Mannan, S. (2012) Lee's Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control. 4th Edition, Butterworth-Heinemann.

(**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.

Please ensure any specific requirements are detailed in this section. Module Co-ordinators should consider the accessibility of their module for groups with protected characteristics..

(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

Programme Board	Engineering
Assessment Results (Pass/Fail)	Yes ☐No ☒
Subject Panel	Engineering
Moderator	Andy Durrant
External Examiner	R Ocone
Accreditation Details	This module is part of the MSc in Chemical Engineering accredited by the IChemE
Version Number	3

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 Category 1: Final exam worth 70% of the final mark.
Assessment Category 2: Continuous assessment presentation (poster) and assignment worth 30%.
(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 Handbook.)

Assessment Outcome Grids **(Footnote A.)**

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	✓	✓			✓	70	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/ Diagram/ Drawing/	✓	✓	✓	✓		20	0

Photograph/ Sketch							
Presentation			✓	✓	✓	10	0
Combined Total for All Components						100%	3 hours