University of the West of Scotland

Module Descriptor

Session: 2024/25

Title of Module: Advanced Heat Transfer			
Code: ENGG11032	**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:	Mojtaba Mirzaeian		

Summary of Module

The course will review boundary layer flow and its influence on rates of heat transfer.

The module also develops the coverage of heat transfer and discusses topics such as convection from first principles, conduction in solids with internal heat generation and numerical methods for modelling conduction in two and three dimensions.

The module tackles the concepts of the “Pinch” technology and discusses topics such as thermodynamic and economic targets of heat exchanger networks based on the second law of thermodynamics, hot and cold composite curves, number of units for maximum energy recovery, stream splitting for maximum energy recovery, problem table algorithms and grand composite curves, multiple utilities and their optimal use, as well as threshold problems. Boilers and furnaces will be covered and the selection of fuels with reference to their environmental impact will be discussed.

Two phase flow internal forced boiling and Nusselt analysis of condensation process for laminar flow will be discussed.

Design and performance calculations of heat exchanger based on the effectiveness-NTU method will be presented.

The course will discuss the intensification of heat transfer processes and heat transfer in micro-channels with practical applications.

Sample industrial applications will be used to illustrate the topics.

During the course of this module students will develop their UWS Graduate Attributes (https://www.uws.ac.uk/current-students/your-graduate-attributes/). Universal: Academic attributes - critical thinking and analytical & inquiring mind; Work-Ready: Academic attributes - knowledge of heat integration modelling software; Successful : autonomous, driven and resilient.

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 heat transfer that covers both depth and breadth of the subject.
L2	Develop advanced and critical knowledge of the role played by heat transfer in the design and analysis of equipment that will also take into consideration issues such as environmental protection, resources conservation and sustainability as well as economic viability.
L3	Develop the underlying knowledge that will enable the analysis and design of equipment, even in the cases of missing and/or incomplete data through published research and innovation.
L4	Develop the advanced skill required to use modern tools such as Aspen Energy Analyser in the design of heat transfer equipment and critical understanding of their scope and limitations.

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 heat transfer and their relevance and application in engineering context and at advance level. • A critical understanding of the principal theories, concepts and principles of advanced heat transfer. • A critical understanding of a range of specialised theories, concepts and principles applied to heat transfer. • Extensive, detailed, and critical knowledge and understanding of the role of heat transfer in engineering applications as well as in other related areas. • Develop a critical understanding of the implication of knowledge of heat transfer principles in the advancement of modern and innovative engineering 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 heat transfer 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 the field of heat transfer. • Apply a range of standard and specialised research and other techniques to advance understanding of heat transfer. • Plan, develop and execute a relevant design based on advanced knowledge, research and innovation. • Demonstrate originality, creativity and critical thinking. • Apply knowledge of heat transfer in a wide variety of 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 heat transfer 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 heat transfer and the application of the concepts in the contexts of both engineering and established technology. • 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 heat transfer. • 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 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:	Suitable engineering or physics undergraduate level study in heat transfer.
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	9
Laboratory/Practical Demonstration/Workshop	3
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: Reay, David, C Ramshaw & A Harvey (2013) Process Intensification, 2nd Edition, Butterworth-Heinemann F N Incropera, D P DeWitt, T. L. Bergman and A. S. Lavine, Fundamentals of heat and mass transfer, 7th Edition, Wiley, 2011. Cengel, Yunus A and Afshin J. Ghajar (2014) Heat and Mass Transfer: Fundamentals & Applications. 5th edition. McGraw-Hill Higher Education. Kemp, I. C. and Lim, J.S., (2020) Pinch Analysis and Process Integration. 3rd Edition. Butterworth-Heinemann Holman J. P. (2018) Heat Transfer. 10th Edition. Upper Saddle River, N.J. : Prentice Hall PTR. Smith R. (2016) Chemical process design and integration. 2nd edition, Wiley-Blackwell. R K Sinnott and G Towler (2019), Chemical Engineering Design: SI Edition, Butterworth-Heinemann 6th Edition. Smith R. (2016) Chemical process design and integration. 2nd edition, Wiley-Blackwell.
(**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	Cristina Rodriguez
External Examiner	R. Ocone
Accreditation Details	This module is part of the MSc Chemical Engineering programme accredited by the IChemE
Changes/Version Number	1.15 - Updated student learning hours - Change of delivery from Blended 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 exam worth 70% of the final mark.
Assessment 2 - Continuous assessment assignments 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 Module Handbook.)

Assessment Outcome Grids (See Guidance Note)

Assessment Type (Footnote B.)	Learning Outcome (1)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Weighting (%) of Assessment Element	Timetabled Contact Hours
Unseen open book	✓	✓			70	3

Assessment Type (Footnote B.)	Learning Outcome (1)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Weighting (%) of Assessment Element	Timetabled Contact Hours
Review/ Article/ Critique/ Paper		✓	✓	✓	30	0
Combined Total for All Components					**100%**	**3 hours**