



**Swansea University  
Prifysgol Abertawe**

**FACULTY OF SCIENCE AND  
ENGINEERING**

**UNDERGRADUATE STUDENT  
HANDBOOK**

**YEAR 3 (FHEQ LEVEL 6)**

**CHEMICAL ENGINEERING  
DEGREE PROGRAMMES**

**SUBJECT SPECIFIC  
PART TWO OF TWO  
MODULE AND COURSE STRUCTURE  
2022-23**

## **DISCLAIMER**

The Faculty of Science and Engineering has made all reasonable efforts to ensure that the information contained within this publication is accurate and up-to-date when published but can accept no responsibility for any errors or omissions.

The Faculty of Science and Engineering reserves the right to revise, alter or discontinue degree programmes or modules and to amend regulations and procedures at any time, but every effort will be made to notify interested parties.

It should be noted that not every module listed in this handbook may be available every year, and changes may be made to the details of the modules. You are advised to contact the Faculty of Science and Engineering directly if you require further information.

## The 22-23 academic year begins on 19 September 2022

Full term dates can be found [here](#)

### **DATES OF 22-23 TERMS**

19 September 2022 – 16 December 2022

9 January 2023 – 31 March 2023

24 April 2023 – 09 June 2023

### **SEMESTER 1**

19 September 2022 – 27 January 2023

### **SEMESTER 2**

30 January 2023 – 09 June 2023

### **SUMMER**

12 June 2023 – 22 September 2023

## **IMPORTANT**

Swansea University and the Faculty of Science of Engineering takes any form of **academic misconduct** very seriously. In order to maintain academic integrity and ensure that the quality of an Award from Swansea University is not diminished, it is important to ensure that all students are judged on their ability. No student should have an unfair advantage over another as a result of academic misconduct - whether this is in the form of **Plagiarism, Collusion** or **Commissioning**.

It is important that you are aware of the **guidelines** governing Academic Misconduct within the University/Faculty of Science and Engineering and the possible implications. The Faculty of Science and Engineering will not take intent into consideration and in relation to an allegation of academic misconduct - there can be no defence that the offence was committed unintentionally or accidentally.

Please ensure that you read the University webpages covering the topic – procedural guidance [here](#) and further information [here](#). You should also read the Faculty Part One handbook fully, in particular the pages that concern Academic Misconduct/Academic Integrity. You should also refer to the Faculty of Science and Engineering proof-reading policy and this can be found on the Community HUB on Canvas, under Course Documents.

## **Welcome to the Faculty of Science and Engineering!**

Whether you are a new or a returning student, we could not be happier to be on this journey with you.

This has been a challenging period for everyone. The COVID-19 pandemic has prompted a huge change in society as well as how we deliver our programmes at Swansea University and the way in which you study, research, learn and collaborate. We have been working hard to make sure you will have or continue to having an excellent experience with us.

We have further developed some exciting new approaches that I know you will enjoy, both on campus and online, and we cannot wait to share these with you.

At Swansea University and in the Faculty of Science & Engineering, we believe in working in partnership with students. We work hard to break down barriers and value the contribution of everyone. Our goal is an inclusive community where everyone is respected, and everyone's contributions are valued. Always feel free to talk to academic staff, administrators, and your fellow students - I'm sure you will find many friendly helping hands ready to assist you.

We all know this period of change will continue and we will need to adapt and innovate to continue to be supportive and successful. At Swansea we are committed to making sure our students are fully involved in and informed about our response to challenges.

In the meantime, learn, create, collaborate, and most of all – enjoy yourself!

**Professor Johann (Hans) Sienz**  
**Interim Pro-Vice Chancellor/Interim Executive Dean**  
**Faculty of Science and Engineering**



<b>Faculty of Science and Engineering</b>	
Interim Pro-Vice Chancellor/Interim Executive Dean	Professor Johann Sienz
Head of Operations	Mrs Ruth Bunting
Associate Dean – Student Learning and Experience (SLE)	Professor Paul Holland
<b>School of Engineering and Applied Sciences</b>	
<b>Head of School: Professor Serena Margadonna</b>	
School Education Lead	Professor Simon Bott
Head of Chemical Engineering	Dr Enrico Andreoli
Chemical Engineering Programme Director	Dr Matt Barrow <a href="mailto:M.S.Barrow@swansea.ac.uk">M.S.Barrow@swansea.ac.uk</a>
Year 3 Coordinator	Dr Chris Phillips <a href="mailto:C.O.Phillips@swansea.ac.uk">C.O.Phillips@swansea.ac.uk</a>

## STUDENT SUPPORT

The Faculty of Science and Engineering has two **Reception** areas - Engineering Central (Bay Campus) and Wallace 223c (Singleton Park Campus).

Standard Reception opening hours are Monday-Friday 9am-5pm.

The **Student Support Team** provides dedicated and professional support to all students in the Faculty of Science and Engineering. Should you require assistance, have any questions, be unsure what to do or are experiencing difficulties with your studies or in your personal life, our team can offer direct help and advice, plus signpost you to further sources of support within the University. There are lots of ways to get information and contact the team:

**Email:** [studentsupport-scienceengineering@swansea.ac.uk](mailto:studentsupport-scienceengineering@swansea.ac.uk) (Monday–Friday, 9am–5pm)

**Call:** +44 (0) 1792 295514 and 01792 6062522 (Monday-Friday, 10am–12pm, 2–4pm).

**Zoom:** By appointment. Students can email, and if appropriate we will share a link to our Zoom calendar for students to select a date/time to meet.

The current student **webpages** also contain useful information and links to other resources:

<https://myuni.swansea.ac.uk/fse/coe-student-info/>

## READING LISTS

Reading lists for each module are available on the course Canvas page and are also accessible via <http://ifindreading.swan.ac.uk/>. We've removed reading lists from the 22-23 handbooks to ensure that you have access to the most up-to-date versions. Access to print material in the library may be limited due to CV-19; your reading lists will link to on-line material whenever possible. We do not expect you to purchase textbooks, unless it is a specified key text for the course.

## THE DIFFERENCE BETWEEN COMPULSORY AND CORE MODULES

**Compulsory modules** must be **pursued** by a student.

**Core modules** must not only be **pursued**, but also **passed** before a student can proceed to the next level of study or qualify for an award. Failures in core modules must be redeemed.

Further information can be found under “Modular Terminology” on the following link -

<https://myuni.swansea.ac.uk/academic-life/academic-regulations/taught-guidance/essential-info-taught-students/your-programme-explained/>

## Year 3 (FHEQ Level 6) 2022/23

### Chemical Engineering

BEng Chemical Engineering[H831,H835]

BEng Chemical Engineering with a Year Abroad[H800]

BEng Chemical Engineering with a Year in Industry[H832]

MEng Chemical Engineering[H801]

MEng Chemical Engineering with a Year Abroad[H802]

Semester 1 Modules	Semester 2 Modules
EG-304 Safety and Loss Prevention 10 Credits Dr YK Ju-Nam CORE	EG-307 Particulate Systems 10 Credits Dr P Bertoncetto CORE
EG-337 Reactor Design II 10 Credits Prof DL Oatley-Radcliffe CORE	EGA323 Energy and Low Carbon Technologies 10 Credits Dr P Bertoncetto CORE
EG-338 Separation Processes II 10 Credits Prof C Tizaoui CORE	EGZ300 Environmental Engineering Practice 10 Credits Dr F Del Giudice CORE
EG-339 Process Equipment Design 10 Credits Dr DJ Curtis CORE	
EGA332 Process Equipment Selection and Control 10 Credits Dr CO Phillips CORE	
EG-386 Engineering Management 10 Credits Prof SG Bott/Prof AR Barron/Dr JM Courtney/Dr M Evans CORE	
EGA326 Chemical Engineering Design Project 30 Credits Dr P Esteban CORE	
Total 120 Credits	

**Year 3 (FHEQ Level 6) 2022/23**  
**Chemical Engineering**  
**MEng Chemical Engineering with a Year in Industry[H890]**

Semester 1 Modules	Semester 2 Modules
<b>EG-304</b> <b>Safety and Loss Prevention</b> <b>10 Credits</b> <b>Dr YK Ju-Nam</b> <b>CORE</b>	<b>EG-307</b> <b>Particulate Systems</b> <b>10 Credits</b> <b>Dr P Bertoncetto</b> <b>CORE</b>
<b>EG-337</b> <b>Reactor Design II</b> <b>10 Credits</b> <b>Prof DL Oatley-Radcliffe</b> <b>CORE</b>	<b>EGA323</b> <b>Energy and Low Carbon Technologies</b> <b>10 Credits</b> <b>Dr P Bertoncetto</b> <b>CORE</b>
<b>EG-338</b> <b>Separation Processes II</b> <b>10 Credits</b> <b>Prof C Tizaoui</b> <b>CORE</b>	<b>EGZ300</b> <b>Environmental Engineering Practice</b> <b>10 Credits</b> <b>Dr F Del Giudice</b> <b>CORE</b>
<b>EG-339</b> <b>Process Equipment Design</b> <b>10 Credits</b> <b>Dr DJ Curtis</b> <b>CORE</b>	
<b>EGA332</b> <b>Process Equipment Selection and Control</b> <b>10 Credits</b> <b>Dr CO Phillips</b> <b>CORE</b>	
<b>EG-233</b> <b>Placement Preparation: Engineering Industrial Year</b> <b>0 Credits</b> <b>Prof GTM Bunting/Dr CME Charbonneau/Dr P Esteban/Dr SA Rolland/Dr V Samaras/Dr S Sharma</b>	
<b>EG-386</b> <b>Engineering Management</b> <b>10 Credits</b> <b>Prof SG Bott/Prof AR Barron/Dr JM Courtney/Dr M Evans</b> <b>CORE</b>	
<b>EGA326</b> <b>Chemical Engineering Design Project</b> <b>30 Credits</b> <b>Dr P Esteban</b> <b>CORE</b>	
<b>Total 120 Credits</b>	



# EG-233 Placement Preparation: Engineering Industrial Year

**Credits: 0 Session: 2022/23 September-June**

**Pre-requisite Modules:**

**Co-requisite Modules:**

**Lecturer(s):** Prof GTM Bunting, Dr CME Charbonneau, Dr P Esteban, Dr SA Rolland, Dr V Samaras, Dr S Sharma

**Format:** 11 hours consisting of a mix of seminars and workshops. 11 one hour drop-in advice sessions. Review of CV and cover letter.

Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

**Delivery Method:** All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

This module is delivered through directed and self-directed learning, careers resources, interactive workshops, reflective learning practice and drop-in advice sessions. The module is delivered on the Bay Campus.

**Module Aims:** This generic cross-disciplinary module is for all students who have enrolled (or transferred) onto the Engineering Year in Industry scheme. The module focuses on the underpinning and fundamental requisites required to gain, enter and progress effectively through an industrial placement. Learners will be introduced to a) sourcing placements, CV writing and application techniques; (b) interview techniques - how to pitch yourself and be successful; (c) workplace fundamentals and IP awareness, behaviours and expectations; (d) key employability skills; getting the most from your Industrial Placement; and (e) health and safety in the workplace.

**Module Content:**

The module will focus on the key requirements to gain and be successful whilst on a placement. Directed and self-directed activity will address the following topics;

- 1) Engineering Industrial Placements - what they are, how to search and how to apply.
- 2) CV writing, cover letters and application processes.
- 3) Assessment centres, interview techniques and mock interviews.
- 4) Recognising and developing employability skills.
- 5) Reflecting and maximising the placement experience.
- 6) One to one meeting with careers and employability staff.
- 7) Health and safety in the workplace.

**Intended Learning Outcomes:**

Technical Outcomes

By the end of this module, students will:

- Know how to find and apply for placements, create a CV and complete a placement application.
- Understand the interview process and gain interview experience.
- Discuss and share what is expected within the workplace including behavioural and professional conduct.
- Identify personal employability skills and how these will be used in a workplace setting.

Accreditation Outcomes (AHEP)

EL5b Awareness of relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety and liability issues

EL6b Knowledge and understanding of risk issues, including health & safety, environmental and commercial risk,

**Assessment:** Placements (100%)

**Assessment Description:**

Students are required to attend the health and safety lecture. Students who do not attend and have no valid reason will not be permitted to continue on an Engineering Industrial Placement Year programme of study.

**Moderation approach to main assessment:** Not applicable

**Assessment Feedback:**

N/A: students will however be able to discuss and seek feedback/advice on their search for an industrial placement, during the drop-in sessions.

**Failure Redemption:**

Successful completion of this module depends upon attendance at, and engagement with, the health and safety lecture. Therefore there will normally be no opportunity to redeem failure. However, special provision will be made for students with extenuating or special circumstances.

**Additional Notes:** Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

This module is only available for students enrolled on the Engineering Year in Industry scheme.

# EG-304 Safety and Loss Prevention

**Credits: 10 Session: 2022/23 September-January**

**Pre-requisite Modules:**

**Co-requisite Modules:**

**Lecturer(s):** Dr YK Ju-Nam

**Format:** Lectures 25 hours  
HAZOP 4 hours  
Directed private study 75 hours  
Contact Hours will be delivered through a blend of live activities online and on-campus.

**Delivery Method:** All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus.

**Module Aims:** This module aims to provide a basic knowledge of the technical issues underlying safety and loss prevention on process plant, introducing risk and hazard assessment together with the legal framework of obligations for organizations and individuals.

## **Module Content:**

The module consists of topic lectures combined with case studies introduced by video footage; technical problems with solution methods and practical HAZOP & Risk Assessment exercises.

Specific topics covered are:

- Fires and Explosions; flammability of gases liquids and solids; ignition sources; electrical and hazardous area classification [5].
- HAZOP assessment [4]
- Inherent Safety [2]
- Toxic Releases [2]
- Hazard and Risk Assessment Methods [5]
- Management Issues, Emergency Planning and the legal framework [3]

## **Intended Learning Outcomes:**

After completing this module students are expected to:

- Evaluate specific hazards associated to hazardous materials and their usage
- Identify potential sources of hazards and risk of major accident events using a range of techniques
- Assess hazards and risks from process control system failures
- Assess the impact of human factors in process operations and design
- Explain how process safety management systems are implemented and operated in industry

**Assessment:** Examination 1 (90%)  
Group Work - Coursework (10%)

**Resit Assessment:** Examination (Resit instrument) (100%)

**Assessment Description:** A HAZOP or risk assessment exercise (this coursework is conducted and assessed in groups), and an end of year examination.

**Moderation approach to main assessment:** Universal second marking as check or audit

**Assessment Feedback:** Marked HAZOP exercise and final examination

## **Failure Redemption:**

Year 3 BEng - BEng students are only permitted to redeem a failure as per University regulations for final year students. If you are eligible for a resit examination this will take the form of a 100% supplementary exam in August.

Year 3 MEng - MEng students are only permitted to redeem a failure as per University regulations for YR3 - YR4 progressing students. If you are eligible for a resit examination this will be the form of a 100% supplementary exam in August.

**Additional Notes:** Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

This module operates with a zero tolerance penalty policy for late submission of all coursework and continuous assessment.

# EG-307 Particulate Systems

**Credits: 10 Session: 2022/23 January-June**

**Pre-requisite Modules:** EG-100; EG-160; EG-161; EG-189; EG-190 ; EG-211

**Co-requisite Modules:**

**Lecturer(s):** Dr P Bertoncello

**Format:** Lectures 20 hours;  
Example classes/tutorials 5 hours;  
Preparation for assessment; 25 hours  
Reading/Private study: 50 hours

**Delivery Method:** On-campus lectures and tutorials.

**Module Aims:** This module aims at presenting the fundamental aspects of transport mechanisms of particles (suspended in fluids) and to illustrate the properties and external conditions that influence the flow of fluids through packed beds, the separation of multiphase systems, separation across phase boundaries in a variety of industrial situations.

## Module Content:

- Motion of particles in a fluid: drag forces, terminal falling velocities; accelerating motion of a particle in the gravitational field; motion of a sphere in the Stokes' law region; motion of particles in a centrifugal field [2].
- Flow of fluids through granular beds and packed columns: Darcy's law and permeability; Carman-Kozeny equation; streamline and turbulent flow [2].
- Sedimentation: sedimentation of fine particles; the thickener; sedimentation of coarse particles [2].
- Fluidisation: general behaviour of gas/solids and liquid/solids systems; effect of fluid velocity on pressure gradient & pressure drop; minimum fluidising velocity; fluidising beds [3].
- Liquid filtration: introduction, theory; relation between thickness of cake and volume of filtrate; compressible & incompressible cakes [4].
- Centrifugation: introduction, theory; sedimentation of a centrifugal field; Filtration with centrifugation [4]
- Crystallisation: introduction, theory and fundamentals; solubility and saturation; crystal nucleation; crystal growth; crystal yield; crystallisation from solutions; fractional crystallisation [3].

## Intended Learning Outcomes:

After completing this module, the student should be able to demonstrate knowledge and understanding of the following:

- (1) Motion of particles through granular beds and sedimentation: calculation of terminal falling and settling velocities of solid particles under different fluid dynamic conditions;
- (2) Fluidisation. Derive expression for minimum fluidising velocity under streamline and turbulent conditions; Evaluation of mass flow rate of flow under fluidisation and transport conditions;
- (3) Principles and operations of separation of particles from fluids: sedimentation, centrifugation, liquid filtration and crystallisation;
- (4) Solutions of practical problems. Typical examples include estimation of minimum area of a thickener; calculation of pressure drop and filtration rate; estimation of the number of filter press frames and their size required to filter a given amount of a slurry; calculation of crystal yield.

**Assessment:** Examination 1 (100%)

## Assessment Description:

Examination 1: final exam on the entire module programme, corresponding to a total mark of 100%.

**Moderation approach to main assessment:** Universal second marking as check or audit

## Assessment Feedback:

Examples questions will be solved in class with related solutions placed on Canvas.

## Failure Redemption:

Year 3 BEng : BEng students are only permitted to redeem a failure as per University regulations for final year students. If you are eligible for a resit examination this will take the form of a 100% supplementary examination.

Year 3 MEng : MEng students are only permitted to redeem a failure as per University regulations for YR3 - YR4 progressing students. If you are eligible for a resit examination this will take the form of a 100% supplementary examination.

**Additional Notes:** Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

This module operates with a zero tolerance penalty policy for late submission of all coursework and continuous assessment.

Notes, worked examples and past papers for this module can be found on Canvas.

# EG-337 Reactor Design II

**Credits:** 10 **Session:** 2022/23 September-January

**Pre-requisite Modules:** EG-204

**Co-requisite Modules:**

**Lecturer(s):** Prof DL Oatley-Radcliffe

**Format:** Lectures 20 hours; Example classes 10 hours; Directed private study 70 hours  
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

**Delivery Method:** All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Notional lectures will be available online and asynchronously via the VLE. These will be supported by assigned reading and alternative online resources where appropriate. Online synchronous worked examples classes and drop in sessions will be scheduled to support student learning. Students will be expected to follow the scheduled workload of learning materials.

## Module Aims:

This module continues to develop the concepts studied in the Level 2 Reactor Design Course (EG-204). The engineering design of reaction vessels will be considered for chemical reaction systems that involve simultaneous reaction with mass transfer limitations in the fluid phase and the solid phase matrix that contain a chemical catalyst. Mathematical modelling of the kinetic rate equations therefore incorporates the concept of a mass transfer limitation effectiveness factor for the solid phase matrix, whilst the fluid mechanics is used to determine the fluid phase transfer limitations. The kinetic rate models are used to develop Design Performance Equations for industrial reaction systems based on the fixed bed catalytic reactor. Other reaction systems are discussed as industrial examples.

**Module Content:** Reactor design concepts including catalysts in heterogeneous systems. Graphical representation and determination of chemical kinetic model parameters. Modelling of catalytic deactivation mechanisms and fluid phase mass transfer limitations in gas-solid catalytic tubular reactors.

Non-Catalytic Gas-Solid Reactions. Case problems. A detailed study of the Shrinking Core model. Gas-Solid Catalytic Reactions. Reactions on catalyst surfaces. Kinetics of heterogeneously catalysed reactions. Diffusion and reactions in porous catalysts. External Mass Transfer. Surface Phenomena and Reaction. Design of Gas-Solid Catalytic Reactors. Packed Bed Reactors.

Diffusion into a porous catalyst particle; modelling of the simultaneous mass transfer and catalytic chemical reaction in the solid phase matrix particle.

Design of industrial packed bed catalytic reactors; configurations for either non-isothermal adiabatic or heat transfer operation with a one dimensional model using dimensional correlations of the fluid mechanics in case studies.

**Intended Learning Outcomes:** On completion, students should have:

1. Knowledge and understanding of kinetic rate models and how these apply to reactor design, the concept of chemisorption and models of solid surface catalysed reactions including more complex systems such as non-catalytic gas-solid reactions.
2. An ability to analyse chemical reactor performance where mass transfer limitations occur (assessed by the mass transfer effectiveness factor), catalytic packed bed reactor engineering and geometry, fluid flow and the relationship between Reynolds No. and pressure drop.
3. The ability to design chemical reactors for a novel duty; using the dimensionless design performance equations, knowledge of the rate limiting step and Damkohler number for evaluating capacity and performance of industrial scale systems.

**Assessment:** Examination 1 (90%)  
Coursework 1 (10%)

**Resit Assessment:** Oral Examination (100%)

**Assessment Description:** Examination 1: End of year examination accounting for 90% of the total mark.

Coursework 1: A series of typical questions relevant to topic areas (numerical calculations on various topics delivered throughout the course): 10%

Oral Examination: Students who fail the primary exam will receive an oral examination in order to redeem this failure. Success will be treated as a threshold pass in-line with Faculty guidelines.

**Moderation approach to main assessment:** Universal second marking as check or audit

**Assessment Feedback:** Formal summative Exam feedback will be given via exam results and the exam feedback form.

Formative feedback will be given via example classes and discussion.

**Failure Redemption:** Year 3 BEng : BEng students are only permitted to redeem a failure as per University regulations for final year students. If you are eligible for a resit examination, this will take the form of an Oral Examination in order to redeem the failure. Success will be treated as a threshold pass in-line with Faculty guidelines.

Year 3 MEng : MEng students are only permitted to redeem a failure as per University regulations for YR3 - YR4 progressing students. If you are eligible for a resit examination, this will take the form of an Oral Examination in order to redeem the failure. Success will be treated as a threshold pass in-line with Faculty guidelines.

**Additional Notes:** Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

This module operates with a zero tolerance penalty policy for late submission of all coursework and continuous assessment.

Lecture slides are provided with worked examples via the VLE.



# EG-338 Separation Processes II

**Credits: 10 Session: 2022/23 September-January**

**Pre-requisite Modules:** EG-200

**Co-requisite Modules:**

**Lecturer(s):** Prof C Tizaoui

**Format:** Lectures 20 hours  
example classes 10 hours  
Directed private study 70 hours

**Delivery Method:** On-campus lectures and example classes.

Module materials are available at Canvas.

**Assessment:** January Assessment 60% and Coursework (3 Canvas tests) 40%

**Module Aims:** This module builds on years 1 and 2 studies of traditional separation processes, extending these to multi-component systems. Short-cut methods are described. The importance of non-ideal behaviour is highlighted in descriptions of azeotropic and extractive distillation. The discussion of absorption is extended to include chemical reactions, and basic knowledge of adsorption and ion exchange separation processes is covered in this module.

**Module Content:** •Vapour liquid equilibrium for multi-component systems [1]

- Single stage flash vaporisation [2]
- Multi-component continuous fractionation and short cut methods for calculating column operating conditions [4]
- Multi-component distillation: rigorous solution methods [2]
- Column efficiencies and tray design [2]
- Extractive and azeotropic distillation [1]
- Multi-component gas absorption [4]
- Adsorption and ion exchange processes [4]

**Intended Learning Outcomes:** After completing this module, students should be able to:

- Demonstrate knowledge and understanding of VLE relationships and use DePriester charts to determine k-values.
- Calculate the composition of mixtures and their dew and bubble points.
- Analyse practical operation of multicomponent equilibrium flash units.
- Apply and evaluate short cut and rigorous methods for the design of multi-component distillation columns and solve difficult separations (azeotropic and extractive distillation).
- Design multi-component absorption columns.
- Demonstrate knowledge and understanding of adsorption and ion exchange processes.
- Select and apply chemical engineering principles to design problems and to select and apply common separation equipment.

**Assessment:** Examination 1 (60%)  
Coursework 1 (10%)  
Coursework 2 (15%)  
Coursework 3 (15%)

**Resit Assessment:** Examination (Resit instrument) (100%)

**Assessment Description:** January Assessment 60% and Courseworks (3 Canvas tests) 40%

Resit: Assessment (100%) - details of the format of assessment will be provided in advance.

**Moderation approach to main assessment:** Universal second marking as check or audit

**Assessment Feedback:** Exam result and exam general feedback forms common across Faculty .

Assignment feedback will be given by individual written comments and personal discussion and assignment mark.

**Failure Redemption:** Year 3 BEng : BEng students are only permitted to redeem a failure as per University regulations for final year students. If you are eligible for a resit examination this will take the form of a 100% supplementary assessment (details of the format of assessment will be provided in advance).

Year 3 MEng : MEng students are only permitted to redeem a failure as per University regulations for YR3 - YR4 progressing students. If you are eligible for a resit examination, this will take the form of a 100% supplementary assessment (details of the format of assessment will be provided in advance).

**Additional Notes:** We will make every effort to engage with students where changes are necessary and any changes will be communicated to students, as soon as possible. Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

This module operates with a zero tolerance penalty policy for late submission of all coursework and continuous assessment.

# EG-339 Process Equipment Design

**Credits: 10 Session: 2022/23 September-January**

**Pre-requisite Modules:**

**Co-requisite Modules:**

**Lecturer(s):** Dr DJ Curtis

**Format:** Contact hours - 25 hours (20 in-person lectures + 5 examples classes)  
Directed private study - 80 hours

**Delivery Method:** Module will be delivered via in-person lectures and examples classes. Supplementary information may be available via the Canvas Digital Learning Platform.

**Module Aims:** The general aims of this module are to analyse manufacturing equipment and processes for the purpose of design and scale-up. The module will focus on aspects of process engineering design for the majority of equipment but will provide examples of detailed design and mechanical design in some cases. In all cases, industrial standards, best practice and safety will be at the heart of any design process to ensure the finalised designs will be reliable and robust, economically viable, safe and sustainable. Areas of design considered will include strength of materials, mechanical design, specification of stirred tanks including aseptic/sterile equipment design for regulation and control of chemical and biological reactions. Heterogeneous systems, in particular, the inter-phase mass transfer of nearly insoluble gases. Heat transfer through jackets, coils, electrical heaters.

**Module Content:** Equipment Design:

- > Objectives of process equipment design. Understanding the design process. Commissioning and validation.
- > Strength of Materials.
- > Pressure Vessel Specification.
- > Mass transfer issues: aeration and oxygen supply to fermenter design. The concept of limiting resistance for mass transfer - development of two film theory. Correlations for mass transfer coefficients. Bubble dynamics and determination of mass transfer coefficient.
- > Scale up of fermenters: Oxygen transfer rates. Power and Reynolds numbers. Mixing characteristics. Bubble hold up. Other factors to consider, such as heat transfer.
- > Batch processing: The concept of the batch process. Design and scale-up of batch processes. Processing methodologies and cycle time analysis.
- > Sterilisation (gas/air): Practical methods for air sterilisation. Filtration. Design examples.

**Intended Learning Outcomes:** Upon completion of this module students should be able to:

- Design process equipment with reference to process requirements, safety and relevant industrial standards.
- Write validation and commissioning procedures.
- Perform scale-up calculations.
- Analyse the suitability of existing equipment to meet new process requirements.

**Assessment:** Examination 1 (90%)  
Coursework 1 (10%)

**Resit Assessment:** Examination (Resit instrument) (100%)

**Assessment Description:** Examination:

One end of module examination accounting for 90% of the total mark

Coursework:

One assessed coursework requiring numerical calculations/interpretation/design accounting for 10% of the total mark.

**Moderation approach to main assessment:** Universal second marking as check or audit

**Assessment Feedback:** Exam feedback will be provided via examination feedback forms and written feedback will also be available for coursework items. Feedback on learning and comprehension will be accessible through office hours.

**Failure Redemption:** A Supplementary Assessment (resembling traditional Exam Paper style) will be provided for students entitled to resit the module - provision of the Supplementary Assessment will be according to the usual rules governing Progression or Completion of studies.

**Additional Notes:** Delivery of both teaching and assessment will be on-campus.

Available to visiting and exchange students.

This module operates with a zero tolerance penalty policy for late submission of all coursework and continuous assessment.

# EG-386 Engineering Management

**Credits: 10 Session: 2022/23 September-June**

**Pre-requisite Modules:**

**Co-requisite Modules:**

**Lecturer(s):** Prof SG Bott, Prof AR Barron, Dr JM Courtney, Dr M Evans

**Format:** Core Lectures 20 hours  
Discipline Specific Lectures 10 hours  
Private Study 70 hours  
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

**Delivery Method:** All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Series of lectures, discipline-specific sections will cover the first 3 weeks and core components will follow.

Important - Careers Services Support lectures will take place in TB1 but formal assessment marks will be released in TB2. Please be aware that this is compulsory and will appear on the TB1 timetable.

One individual assignment for the discipline-specific component (30%) and two canvas-based electronic examinations (65% (2 x 32.5%)) for the core component, plus 5% careers services assessment .

**Module Aims:** The goal of this course is to provide the skills for science and engineering to meet the challenges of their future careers, whether they be in academia, industry, or as an entrepreneur. Irrespective of future careers engineers will be involved in projects and an awareness of the factors that enable a successful project is important for all team members. It should be recognized that the topics included in the course are not limited to scientists and engineers, they are useful for people in any careers. This course is not aimed at making you a certified project manager, but to provide the skills that will allow you to be a more effective project team member and also when you are dragged screaming and kicking into the role of accidental project manager.

With respect to human resources, the course will cover the basic concept of entrepreneurship before breaking down the essential elements of a business plan. The course will give the more entrepreneurial students guidance about how to go about commercialising their ideas and the less entrepreneurial students an understanding of what makes some of their colleagues tick. The learn by example approach adopted for this module guides the student through the complexities of financial and human resource management and encourages students to develop their own business plans. Students will also be introduced to the subject area of ethics within business. This module will also provide support on careers services with students creating CVs and Linked-In accounts.

**Module Content:** Pre-component  
Careers Services Support - CV and Linked-In account

#### Section A. Programme Specific Component

There are four programme specific components:

- Civil, Chemical (including Environmental), Mechanical and Aerospace/Materials/Electrical/Medical Engineering.
- Chemical Engineering - Lectures on project appraisal in the chemical industries.
- Mechanical and Aerospace - Lectures on manufacturing processes and producing costing worksheets for specific processes.
- Materials/Electrical/Medical Engineering - Lectures on modelling, simulating and then optimising manufacturing products and processes.

#### Section B. Core Component

##### Project Management

- What is a Project?

Definition of a project and the stages within a project; project characteristics;

- Project Stakeholders

Who is involved in a project? The Politics of a project

- What is Project management and a Project manager?

Areas of expertise; what makes a successful project manager; triple constraint; standards and knowledge; management knowledge and skills

- Project Life Cycle

Initiation, planning, execution and closure; Project charter; Objectives and Scope; Project planning; Scope;

Requirements; Work breakdown structure; network diagram; resource planning; Contract type; Risk management

- Entrepreneurship: Team building & Finance / Business Start-ups / The Business Plan including:

Team building and Entrepreneurial Finance.

Risk and Reward. How to set up a new company.

How to write a business plan.

#### **Intended Learning Outcomes:**

##### Technical Outcomes

Upon completion of the module the student should be aware of:

- Some of the "tools" that assist in the efficient use of financial & human resources in manufacturing;
- Writing a project plan
- How to determine if a project is a success
- Legal, human and economic aspects of entrepreneurship;

##### Accreditation Outcomes (AHEP)

- Knowledge of relevant legal and contractual issues (P5)
- Apply their skills in problem-solving, communication, working with others, information retrieval, and the effective use of general IT facilities (G1)
- Understanding of, and the ability to work in, different roles within an engineering team (P11)
- Knowledge and understanding of risk issues, including health & safety, environmental and commercial risk, and of risk assessment and risk management techniques (EL6)
- Work with information that may be incomplete or uncertain and quantify the effect of this on the design (D3B).
- Awareness of relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety, and liability issue (EL5)
- Understanding of appropriate codes of practice and industry standards (P6)
- Awareness of quality issues and their application to continuous improvement (P7)

**Assessment:** Coursework 1 (3%)  
Assignment 1 (30%)  
Examination 1 (65%)  
Coursework 2 (2%)

**Resit Assessment:** Examination (Resit instrument) (100%)

**Assessment Description:**

The core component is assessed via two 1 hour canvas-based electronic examinations. (Equally weighted and contributing 65% to the module grade).

The program specific components are assessed through one piece of coursework that is program specific (contributing 30% to the module grade).

There will also be a 5% component on Careers Support that will be completed in TB1 - 3% for completion of 5 specified units of the 'career development course' and 2% for CV (which will be assessed using 'VMOCK').

This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 30% in the exam component. If you achieve less than 30% in the exam, then the module mark will be just the exam mark.

**Moderation approach to main assessment:** Universal second marking as check or audit

**Assessment Feedback:**

Students will receive feedback on their coursework, together with a model answer, within three weeks of submission. Feedback for the examination will be released via the exam feedback form.

**Failure Redemption:**

Year 3 BEng : BEng students are only permitted to redeem a failure as per University regulations for final year students. If you are eligible for a resit examination this will take the form of 100% supplementary examination.

Year 3 MEng : MEng students are only permitted to redeem a failure as per University regulations for YR3 - YR4 progressing students. If you are eligible for a resit examination this will take the form of 100% supplementary examination.

**Additional Notes:** Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Penalty for late submission of work: ZERO TOLERANCE.

The module is available to exchange students.

Notes and worked examples can be found on Canvas.

This module is assessed by a combination of examination and continual assessment. In order for the continual assessment marks to count, you must achieve at least 30% in the exam component. If you achieve less than 30% in the exam component, then the module mark will be just the exam mark.

<b>EGA323 Energy and Low Carbon Technologies</b>	
<b>Credits: 10 Session: 2022/23 January-June</b>	
<b>Pre-requisite Modules:</b>	
<b>Co-requisite Modules:</b>	
<b>Lecturer(s):</b> Dr P Bertoncello	
<b>Format:</b>	Lectures 20 hours; Example classes/tutorials 5 hours; Preparation for assessment; 25 hours Reading/Private study: 50 hours
<b>Delivery Method:</b> On campus lectures and tutorials.	
<b>Module Aims:</b> This module aims to present fundamental aspects of energy generation using low carbon technologies.  The module will describe the following: <ul style="list-style-type: none"> <li>• Description of the concept of "Hydrogen economy"; Hydrogen generation and purification; Power To Gas;</li> <li>• Energy generation using fuel cells: Proton exchange fuel cells (PEMs), solid oxide fuel cells (SOFCs), molten carbonate fuel cells (MCFCs), phosphoric acid fuel cells (PAFCs), alkaline fuel cells (AFCs); methanol fuel cells (MeFCs).</li> <li>• Solar energy generation: Silicon-based photovoltaic cells, Gratzel and Organic photovoltaic cells; Perovskite solar cells;</li> <li>• Definition and description of batteries: Rechargeable batteries: Li-ion, Li-ion polymer, Na-ion, Na-air, and NiMH batteries;</li> <li>• Supercapacitors as energy generators. Wind and Tidal Energy generation; Geothermal Energy.</li> </ul>	
<b>Module Content:</b> Introduction Introduction to energy generation using organic and inorganic materials. Theory and Principles. Hydrogen generation: general description of current industrial processes for hydrogen generation and related environmental implications; Power to Gas Fuel cells: Introduction and principles of fuel cells. Definition of efficiency. Description of proton exchange fuel cells (PEMs), solid oxide fuel cells (SOFCs), molten carbonate fuel cells (MCFCs), phosphoric acid fuel cells (PAFCs), alkaline (AFCs) fuel cells, methanol fuel cells (MeFCs). Case studies. Solar energy generation: Theory and principles. Energy generation using inorganic and organic materials. Energy storage. Case studies. Rechargeable batteries: Principles and theory. Introduction to Li-ion, Li-ion polymer and NiMH batteries. Supercapacitors. Case studies. Other renewables: Wind, Tidal and Geothermal Energy: Theory and engineering aspects.	
<b>Intended Learning Outcomes:</b> After completing this module students should be able to apply fundamental chemical engineering knowledge to the area of energy generation; Gather, review and interpret technical information from a variety of sources; Analyse, interpret and question published research. Specifically: <ol style="list-style-type: none"> <li>(1) Understand, describe, and assess the methods for the generation and purification of hydrogen;</li> <li>(2) Evaluate and analyse the characteristics and properties of fuel cells and their applications;</li> <li>(3) Describe and critically evaluate the theory and principles at the basis of design of modern batteries and supercapacitors; Evaluate and assess efficiency, and the concept of charge/discharges and number of cycles; Compare and analyse the performances of various batteries (Li metal, Li-ion, NiMH, NiCd, Na-air);</li> <li>(4) Describe the theory and principles at the basis of photovoltaic cells; Identify, and analyse the characteristics of various photovoltaic cells and compare their efficiency;</li> <li>(5) Describe and appraise the generation of energy using other renewable sources (Wind, Tidal, Geothermal).</li> </ol>	
<b>Assessment:</b>	Examination 1 (100%)
<b>Resit Assessment:</b>	Examination (Resit instrument) (100%)
<b>Assessment Description:</b> Final examination: 100% mark	
<b>Moderation approach to main assessment:</b> Universal second marking as check or audit	
<b>Assessment Feedback:</b> There is no assessed work. Model answer to past exams will be placed in Canvas.	

**Failure Redemption:**

Year 3 BEng : BEng students are only permitted to redeem a failure as per University regulations for final year students. If you are eligible for a resit examination this will take the form of a 100% supplementary examination.

Year 3 MEng : MEng students are only permitted to redeem a failure as per University regulations for YR3 - YR4 progressing students. If you are eligible for a resit examination this will take the form of a 100% supplementary examination.

**Additional Notes:** Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

This module operates with a zero tolerance penalty policy for late submission of all coursework and continuous assessment.

Notes, worked examples and past papers for this module can be found on Canvas.

# EGA326 Chemical Engineering Design Project

**Credits: 30 Session: 2022/23 September-June**

**Pre-requisite Modules:** EG-200; EG-204; EG-206; EG-210

**Co-requisite Modules:** EG-304; EG-337; EG-338; EG-339; EGA332

**Lecturer(s):** Dr P Esteban

**Format:** 40 hours tutorials (An initial project brief in one lecture, then a series of tutorial sessions designed to answer questions and give guidance on further progress). Directed private study 260 hours.  
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars, practical sessions and Academic Mentoring sessions.

**Delivery Method:** All Programmes will employ a blended approach to delivery using the Canvas Digital Learning Platform for live and self-directed online activity, with live and self-directed on-campus activities each week. Students may also have the opportunity to engage with online versions of sessions delivered on-campus

Live face to face lectures in lecture theatre.

**Module Aims:** This module aims to give students experience in handling a complex and integrated engineering process design. This task will require, and so reinforce, the material taught throughout the undergraduate course and an additional amount of material from directed private study. The module provides transferable skills related to working in a team environment on a major project.

## **Module Content:**

The project involves preparation of:

- A feasibility study and evaluation of alternative process available to meet the design specification and choose, with justification, the most appropriate one;
- A full material balance of the entire proposed process plant;
- Sufficient energy balances to define process operational conditions and service requirements;
- A detailed process Flow Diagram, (PFD), and an Equipment Schedule Listing;
- An approximate sizing of all major items of process equipment in that section of the process plant allocated to an individual member of the design team, and the mechanical design of one major unit in that section of the process plant;
- A review of safety and loss prevention, including HAZOP/HAZAN and the Dow Fire and Explosion Index of at least one major unit by each individual member of the design team with reference to health and safety and the use of globally competitive engineering designs;
- An Environmental Impact Assessment by each individual member of the design team of their allocated section of the proposed process plant, placing the findings into the context of the entire process plant operations;
- An estimation of capital and operating costs by each individual member of the design team for their allocated section of the process plant, placing these costings into the context of the entire process plant economics.
- Produce a comprehensive design report.
- Maintain project management information and tools throughout the duration of the project.

## **Intended Learning Outcomes:**

After completing this module a student should be able to demonstrate a knowledge and skill in the area of:

- Concept design of a chemical or biological processing facility.
- Detailed design of at least one major item of equipment.
- Sustainability of the selected design, including safety.
- Professional transferable skills.

**Assessment:** Report (100%)



**Assessment Description:**

Each TEAM (or individual) is required to submit a series of Tasks.

Activity Nature Description

Task 1 Group/Individual Design Presentation

Task 2 Individual Individual Unit Design

Task 3 Group Final Design Report

Task 4 Individual Peer Review

Task 5 Group Final Presentation

Deadlines will be issued for each task and failure to achieve the deadline will result in a loss of marks as the Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment. Therefore any assessments submitted after the submission date will be awarded a mark of zero.

Engagement in the design project is essential in order for students to effectively participate in the team activities and to benefit from the wider learning outcomes. Team tutor meetings will be used to discuss technical issues and to assist in time management of the work activities. A portion of the final grade is allocated to engagement as measured by the team tutor and is based on consistent effort and attendance at tutor design sessions.

A peer review process will take place at the end of the group exercise (final report) and the results will contribute towards the final mark.

Attendance of the module synchronous sessions is COMPULSORY for this module and is monitored; this is to ensure that information is consistently delivered to all teams. The attendance score will contribute to the final mark.

One final overall mark is given at the end of TB2 after examination boards have met to ratify marks (no task submission marks are given, only feedback). Overall assessment mark is generated as

Overall score = Sum (Task 1, 2, 3, 5) + Engagement Score + Peer Review factor

Note: the individual task 2 component of this module must be passed (40%) in order to receive marks associated with the team activities.

**Moderation approach to main assessment:** Second marking as sampling or moderation

**Assessment Feedback:** Assessment Feedback: Informal continuous feedback will be provided during tutorials and the lecture class. Formal feedback will be provided during the detailed design presentation and following completion of the final design report in line with standard Faculty of Science and Engineering protocols. No marks other than the final module mark will be directly issued to students.

**Failure Redemption:** Where a student has failed the module, a redemption mechanism is provided in EGA326, this will involve undertaking a new individual unit operation design task.

**Additional Notes:** Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

NOT directly available to visiting and exchange students. Attendance on this module is COMPULSORY and monitored.

Deadlines will be issued for each task and failure to achieve the deadline will result in a loss of marks as the Faculty of Science and Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment. Therefore any assessments submitted after the submission date will be awarded a mark of zero.

Plagiarism will be dealt with via the standard Faculty rules. However, due to the nature of the work involved in this module students are expected to quote design standards, books and other literature sources. Where this is the case, accurate referencing is mandatory.

# EGA332 Process Equipment Selection and Control

**Credits: 10 Session: 2022/23 September-January**

**Pre-requisite Modules:**

**Co-requisite Modules:**

**Lecturer(s):** Dr CO Phillips

**Format:** Typically 20 hours of Lectures and 5 hours examples delivered in person. Additional directed activities via Canvas.

**Delivery Method:** On campus lectures and examples incorporated

**Module Aims:** Newly employed graduate process engineers need to be able to perform a wide range of fundamental process engineering calculations. This module will focus on ancillaries to main process equipment, with emphasis on pump selection, line sizing and pressure drop, pressure relief calculations and utilities. The module also builds upon topics covered in EG-206 (Instrumentation, Measurement and Control) to further develop students understanding of process automation with specific emphasis on the quantitative aspects of process control.

**Module Content:** Selection:

Pumps and line sizing: What type of pump for what duty e.g. centrifugal vs positive displacement etc. Sizing and selection of pumps, which includes producing system curves, using pump laws, calculating NPSH, controlling flow by variable pump speed, control valves or orifice plates. How to size control valves. Line sizing.

Pressure relief calculations: How to determine why and when pressure relief devices are required, different types of pressure devices, how to size pressure relief devices and associated equipment.

Utilities and P&ID's Steam, water, air, nitrogen supply and distribution design. Elements of hot oil system design. Reading and interpreting P&ID's.

Control:

Incentives for control, control loops and PID control.

Process dynamics, Laplace transforms and transfer functions.

Stability and control loop tuning.

Control system design.

**Intended Learning Outcomes:** After completing this module students should be able to:

Select process equipment with reference to specific process requirements, process operation and safety.

Develop specifications for pump, pipework and pressure relief systems.

Specify a basic control strategy for elements of a chemical plant and explain strategies for control loop tuning.

Analyse the dynamics of a process subject to a control system using transfer functions.

**Assessment:** Examination (100%)

**Resit Assessment:** Examination (Resit instrument) (100%)

**Assessment Description:** Assessment in January (100%)

**Moderation approach to main assessment:** Universal second marking as check or audit

**Assessment Feedback:** Exam result and exam general feedback forms common across Faculty.

Optional exercise feedback will be given via marks, individual written comments and model answers.

**Failure Redemption:**

Year 3 BEng : BEng students are only permitted to redeem a failure as per University regulations for final year students. If you are eligible for a resit examination this will take the form of a 100% supplementary examination.

Year 3 MEng : MEng students are only permitted to redeem a failure as per University regulations for YR3 - YR4 progressing students. If you are eligible for a resit examination this will take the form of a 100% supplementary examination.

**Additional Notes:** Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

This module is NOT available for visiting students.

This module operates with a zero tolerance penalty policy for late submission of all coursework and continuous assessment.

# EGZ300 Environmental Engineering Practice

**Credits: 10 Session: 2022/23 January-June**

**Pre-requisite Modules:**

**Co-requisite Modules:**

**Lecturer(s):** Dr F Del Giudice

**Format:** Lectures: 25 hours  
Office hours: 55 hours  
Directed private study: 100 hours

**Delivery Method:** One lecture hour will be dedicated to the presentation of the piece of equipment or technique employed for purification purposes together with the relevant equations and methodology to solve problems. A second lecture will focus on verification problems (design and process parameters are given), while the third one on design problems (design and process parameters are unknown and they require fixing some degrees of freedom). The same pattern will repeat each week.

**Module Aims:** Environmental impact of industrial processes is at the corner stone of process engineering. All the industrial processes are subjected to strict environmental regulations, including those on emissions and pollution. Therefore, the design of a chemical plant cannot be based on process considerations only, but it requires detailed environmental considerations. In many cases, actually, environmental considerations are those that drive the design of a specific process or unit operation. Without a quantification of the environmental impact, no productive process can be run.

This class will introduce the student to the environmental pollution caused by industrial and every day life activities. We will present practical procedures to reduce pollutant (solid and gaseous) contained in industrial process streams down to the legislation level. Students will also learn how to quantify the emissions by using the IChemE sustainability metrics.

**Module Content:** 1. Introduction to the module. Learning outcomes. Exam and Assignments structure. [1]

2. IChemE metrics to quantify the environmental impact of an industrial process. [3]

3. Sedimentation chambers. [3]

4. Cyclone separators. [3]

5. Electrostatic precipitators. [2]

6. Pieces of Equipment in Series and Parallel. [1]

7. Procedures for CO<sub>2</sub> and H<sub>2</sub>S purification. [3]

8. Procedures for SO<sub>2</sub> purification. [3]

9. Procedure for NO<sub>x</sub> purification. [3]

10. Design of an industrial system for the purification of gas streams from solid and gaseous pollutants [3]

**Intended Learning Outcomes:** At the end of this module students will be able to:

- (i) Analyse and quantify the impact of industrial processes on the environment.
- (ii) Design a purification plant to fulfil environmental legislations.

**Assessment:** Examination 1 (100%)

**Resit Assessment:** Examination (Resit instrument) (100%)

**Assessment Description:** 2.5-hour closed book exam to be completed in-person during the exam session. The formula sheet comprehensive of all the required graphs and numerical expressions is provided.

**Moderation approach to main assessment:** Not applicable

**Assessment Feedback:** General final feedback will be provided after formal ratification of the assessment results.

**Failure Redemption:** Year 3 BEng : BEng students are only permitted to redeem a failure as per University regulations for final year students. If you are eligible for a resit examination this will take the form of a 100% supplementary examination.

Year 3 MEng : MEng students are only permitted to redeem a failure as per University regulations for YR3 - YR4 progressing students. If you are eligible for a resit examination this will take the form of a 100% supplementary examination.

Resit: Examination 100%

2.5-hour closed book exam to be completed in-person during the exam session. The formula sheet comprehensive of all the required graphs and numerical expressions is provided.

**Additional Notes:** "Available to visiting and exchange students.

A scheme of direct private study supports lecture notes, and relevant reading material provided.

The lectures will not be recorded and the students are expected to engage in the class activities. The lectures will be highly interactive and the students will be asked to contribute to discussions in order to receive direct feedback from the lecturer: this approach has been widely appreciated by previous cohorts of students on different modules in terms of receiving relevant and specific feedback in preparation for the exam. Therefore, this type of lecture is not appropriate for lecture recording. Students that cannot attend one or more lectures are warmly invited to visit the lecturer during office hours to receive feedback. All the activities will be sign-posted on Canvas and the material available will be sufficient to complete successfully the final assessment. Lecture attendance is the opportunity to engage directly with the lecturer and work with peers to solve problems related to the impact of pollutants on the environment and ways to reduce such impact."