Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

POSTGRADUATE RESEARCH DEGREE STUDENT HANDBOOK

EngD in MATERIALS, MODELLING AND MANFACTURING (FHEQ Level 8)

SUBJECT SPECIFIC (PART TWO OF TWO) MODULE AND COURSE STRUCTURE 2023-24

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.

ACADEMIC YEAR 2023-2024

Full semester and term dates are available here.

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.

CONTENTS

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.

At Swansea University and in the Faculty of Science and 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, technical and administrative staff, administrators - I'm sure you will find many friendly helping hands ready to assist you. And make the most of living and working alongside your fellow students.

During your time with us, please learn, create, collaborate, and most of all – enjoy yourself!

Professor David Smith
Pro-Vice-Chancellor and Executive Dean
Faculty of Science and Engineering

Faculty of Science and Engineering	
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School of Engineering and Applied Sciences	
Head of School	Professor Serena Margadonna
School Education Lead	Professor Simon Bott
Head of Materials Science and Engineering	Professor Trystan Watson
Programme Director	Professor James Sullivan

CONTACTS

If you have any questions about the programme, please contact your supervisors or a member of the COATED Materials and Manufacturing Academy (M2A) Team (refer below).

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COATED M2A OFFICE

For COATED M2A specific enquiries please email m2a@swansea.ac.uk and send any ordering enquiries to m2apurchasing@swansea.ac.uk. The COATED M2A Project Team are based in Room A201a, Engineering East, with exception of the Programme Directors. The team can help with ordering equipment for your project, printing posters for conferences, theme review and project related issues as well as being the contact for absences and booking of annual leave.

STUDENT SUPPORT

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

Standard Reception opening hours are Monday – Friday 8.30am-4pm.

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 (Monday–Friday, 9am–5pm)

Call: +44 (0) 1792 295514 (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 otherresources: https://myuni.swansea.ac.uk/fse/

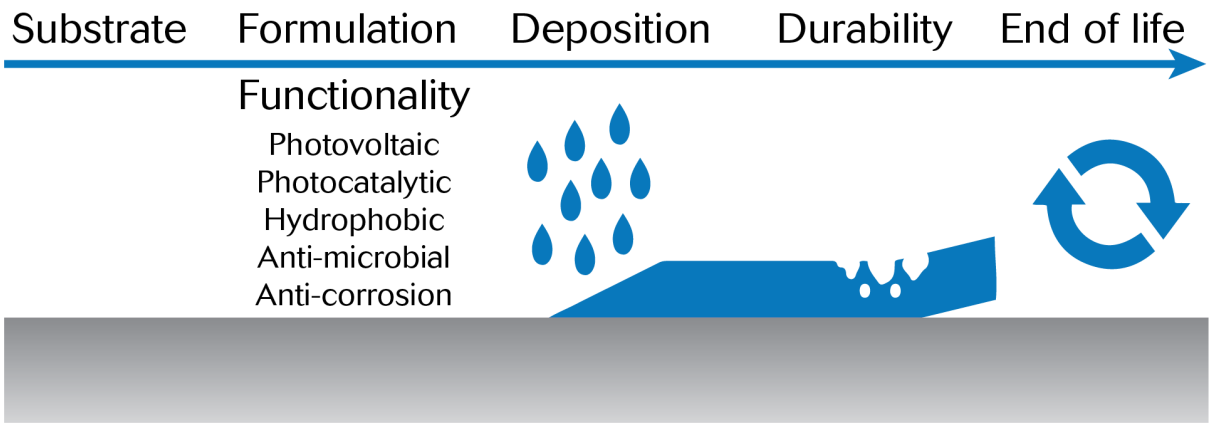
INTRODUCTION TO THE ENGD PROGRAMME

The Engineering Doctorate (EngD) in Materials, Modelling and Manufacturing at Swansea University is a professional four-year research degree undertaken in partnership between the University and a diverse range of organisations within the engineering sector.

The Engineering and Physical Sciences Research Council (EPSRC) regard the EngD scheme as highly prestigious, and you will be referred to as a 'Research Engineer' (RE) to emphasise the professional nature of the degree.

Funding for those on the EngD is primarily via the **Engineering and Physical Sciences Research Council (EPSRC) Centre for Doctoral Training (CDT) in Functional Industrial Coatings**, a £4.5 million project funded by UK Government via UK Research and Innovation (UKRI). The CDT is focused on providing a total of 50 EngD REs during the lifespan of the grant with the technical and research excellence to develop and manufacture new functional industrial coatings and to gain the professional skills to become industry and academic leaders.

Coatings are abundant throughout day-to-day life and ensure the function, durability and aesthetics of millions of products and processes. The use of coatings is essential across multiple sectors including construction, automotive, aerospace, packaging and energy; however, today, there is a focus for them to be sustainably sourced and easily recycled. Projects supported by the CDT will cover everything from substrate and coating formulations though to corrosion performance and end of life.



COATED M2A

The COATED brand of the EPSRC Centre for Doctoral Training in Functional Industrial Coatings is encompassed within the Materials and Manufacturing Academy (M2A), a £25 million project funded by the European Social Fund (ESF) via the Welsh European Funding Office (WEFO). The aim of the project was to increase the affluence of Wales and the UK by delivering highly skilled individuals that can enter the industrial sector and drive the knowledge economy, improving employment prospects and prosperity for all.

The EngD will combine a challenging PhD-style research project/thesis conducted with industry together with activities comprising formal training (modules), informal training (for example, quarterly theme reviews) and organised events such as the COATED M2A Annual Conference to broaden your industrial experience.

TRAINING PROGRAMME STRUCTURE

The training element of the programme will consist both of formal training (via examined lecture courses) together with informal training.

1) FORMAL TRAINING

The training programme typically comprises of 180 credits with:

- 120 credits of technical training delivered primarily in year 1 to provide a technical foundation for the research project; and
- 60 credits of professional skills delivered across years 1-4 to facilitate progression into employment.

The functional coatings modules reflect the current areas of industrial demand, the focus of the EPSRC and the recommendations of the Steering Committee.

The technical modules and interpersonal skills are front loaded in year 1 of the course, primarily conducted between October and February and followed by the 'Literature Review' module commencing in March.

Additionally, some REs attend EGTM38 'Elements of Materials Selection'. The non-credit bearing module is **optional** for Materials Science and Engineering graduates.

It should be emphasised that the EngD is a research degree and not a taught doctorate; however, to allow formal recognition of the training component, each section of the taught programme is examined and assigned credits. REs must successfully complete the 180 credits of training, passing each component with a mark of over 50%.

The modules are assessed through a mixture of formal examinations, assignments and laboratory practicals. As stated previously, the technical training is focused on year 1 to assist you with progression onto your research project.

Table 1 lists all modules and descriptors can be found at **Appendix 1**. The profile of modules and assessment methods for each year are shown in **Table 2**. Year 3 has only one training module to maximise research output during this period.

Table 1 – portfolio of technical and professional skills modules

All modules are 10 credits unless specified. Refer to **Appendix 1** for module descriptors.

* EGTM38 is non-credit bearing and optional for Materials Engineering graduates.
** 'Responsible Research and Innovation' is non-credit bearing but compulsory for all.

Functional Coatings Technical Modules	Professional Skills Modules
EGTM38 Elements of Materials Selection*	EGGM00 Ethics in Engineering
EGSM03 Literature Review of Industrial Problem (30 credits)	EGSM02 Interpersonal Skills for Engineers
EGSM06 Deposition of Functional Materials by Printing and Coating	EGSM08 Economic Appraisal of Engineering Projects
EGSM11 Public Engagement and Science Communication	EGSM09 Industrial Process Control and Optimisation
EGSM12 Applied Instrumental and Analytical Techniques	EGSM10 Entrepreneurship for Research Engineers
EGTM101 Application of Metallic Coatings	EGSM34 Leadership and Complexity Management
EGTM102 Substrate Technology for Functional Coatings	Responsible Research and Innovation**
EGTM103 Degradation of Materials	
EGTM104 Organic Coatings	
EGTM98 Electrochemistry	
EGTM99 Functional Coatings	

Table 2 – year by year profile of modules and assessment methodologies

Note: Assessment method may be subject to change

Year 1 – Total 130 credits

Functional Coatings Technical Modules		
EGSM03	Literature Review of Industrial Problem	Written report – individual (75%) & Viva (25%)
EGSM06	Deposition of Functional Materials by Printing & Coating	Examination (50%) – multiple choice & Coursework (50%) – technical report
EGSM12	Applied Instrumental and Analytical Techniques	Assignment (100%) – essay (3000 words)
EGTM101	Application of Metallic Coatings	Examination (100%)
EGTM102	Substrate Technology for Functional Coatings	Examination (100%)
EGTM103	Degradation of Materials	Coursework (50%) – questions & case studies and Online Multiple-Choice Questions/Canvas Test (50%)
EGTM104	Organic Coatings	Other (100%) - report
EGTM98	Electrochemistry	Examination (100%)
EGTM99	Functional Coatings	Assignment (100%) - 4 page report

Additionally, REs may take (optional for Materials Engineering graduates):

EGTM38	Elements of Materials Selection	Non-credit bearing

Professional Skills Modules		
EGSM02	Interpersonal Skills for Engineers	Presentation (50%), Assignment (50%) – abstract & project plan; Group Work – practical (0%)
EGSM09	Industrial Process Control and Optimisation	Other (100%) – computer-based assignment
N/A	Responsible Research and Innovation	Non-credit bearing

Year 2 – Total 20 credits

Professional Skills Modules		
EGGM00	Ethics in Engineering	Assignment (80%) – essay (2000 words) & presentation (20%)
EGSM10	Entrepreneurship for Research Engineers	Other (100%) – Business model 'lean canvas' and 500 word reflection.

Year 3 – Total 10 credits

Functional Coatings Technical Modules		
EGSM11	Public Engagement and Science Communication	Other (100%) – attendance at Royal Institution workshops. Submission of a document outlining a proposal for an outreach & engagement event at the Swansea Science Festival & a draft Research as Art piece.

Year 4 – Total 20 credits

Professional Skills Modules		
EGSM08	Economic Appraisal of Engineering Projects	Other (100%) - computer based assignment
EGSM34	Leadership and Complexity Management	Coursework (100%) – self & team diagnostic report (1000 words) and presentation

Module Delivery

Modules will be delivered in an intensive two-week format with three to four days of formal lectures in week one with the assessment at the end of week two. This intensive delivery has proved popular with past cohorts and permits attendance of industrial delegates to the courses. The exception to this is the 30 credit 'Literature Review' module that will be conducted & assessed within a three-month period. Modules will typically run once per year.

If you fail to pass the module or miss the module through illness you will be required to take/re-sit the module at the earliest available opportunity.

The Academic Regulations for the Degree of Professional Doctorate outline that:

- Candidates are required to sit examinations at the time specified by the Faculty/School and/or to submit assignments by the specified deadlines. Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.
- The pass mark for all training modules shall be 50% and there shall be no condoned failures.
- Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.
- Candidates who pass the training module at the second attempt/re-sit shall obtain an uncapped mark.
- Failure of a training module at the second attempt shall result in the Faculty/School recommending to the Progression and Awards Board that the candidate either:

  1) be required to withdraw from the programme;

  2) be required to withdraw from the programme and the University.
- Candidates who fail more than one training module shall be required to attend an interview with the programme director and Industrial/Professional representatives. If as a result of this interview the Faculty/School recommends that the candidate be withdrawn, the Progression and Awards Board will require the candidate to withdraw from the programme with immediate effect.

Chartered Engineering status

On completion of the EngD, you will have accrued 180 credits at FEHQ level 7. This fact should be beneficial in counting towards the further learning (beyond an undergraduate degree) required by Professional Engineering bodies for award of *Chartered Engineer* status. The modules have been designed with reference to the Engineering Council's UK-SPEC for Chartership to ensure that the training programme provides maximum benefit to you in terms of continuing professional development.

2) INFORMAL TRAINING

There will also be a component of **informal training**; this will include for example, production of quarterly reports, an impact poster, quarterly theme review presentations and an annual report. Such tasks will provide you with ample opportunities to improve your written and presentation skills. There will also be a range of other informal learning opportunities, for example, health and safety and equipment training where required and completion of University on-line training covering for example, 'General Data Protection Regulation – data protection briefing', 'Equality, Diversity and Inclusivity' and 'Unconscious Bias'. All REs must aim to participate in a minimum of one outreach event per annum. Such opportunities are compulsory but not credit bearing.

RESEARCH PROJECT/THESIS

A key element of the EngD is a four-year doctoral level research project, which is initially proposed by the industrial company in consultation with the COATED M2A Project team.

You will typically have one Industrial Supervisor and two Academic Supervisors. Additionally, we have a range of life/career mentors to aid and encourage continuing professional development opportunities to offer advice, training support and encourage the development of student led forums and activities.

The project specifications are agreed in advance of your appointment; however, they can be refined with you during your first year at the Confirmation of Candidature phase which is conducted three months into the project.

You will undertake the research under the guidance of the Industrial and Academic Supervisors. The research will culminate in the production of a thesis at the end of the four years, which is then examined, in accordance with University regulations; typically, by one external examiner and defended in a viva examination. In addition, as part of the viva examination, you will be required to give a presentation to an open/invited audience including the internal and external examiners.

During the research project, you will normally make three presentations a year and a poster or platform presentation on your work at the COATED M2A Annual Conference. Furthermore, you will be encouraged to present at an international conference, to partake in the University's '3 Minute Thesis' and 'Research as Art' competitions' and to submit three to four papers to peer-reviewed upper quartile journals.

APPENDIX 1

FHEQ Level 7 Module Descriptors

Modules are listed alphabetically by module code.

READING LISTS

Reading lists, where supplementary information is required for the module are available on the course Canvas page and are also accessible via http://ifindreading.swan.ac.uk/. We have removed reading lists from the 2023-24 handbooks to ensure that you have access to the most up-to-date versions. We do not expect you to purchase textbooks unless it is a specified key text for the course.

EGGM00 Ethics in Engineering

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): External Provider / Prof JH Sullivan, Dr DJ Warren

Format: 20 hours lectures
80 hours private and directed study

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

Lectures, Case studies and Small working groups, based at Bay Campus.

Module Aims: This course is designed to provide students with a background to the complex ethical and professional issues that are found in engineering. The focus will be on relevant situations that the engineer/scientist may encounter in their career.

Module Content: General engineering codes of Ethics
Specific ASME code of ethics
Risk and risk management for engineers
Ethics and Leadership
Integrity in Management
Research ethics
Ethical theories applied
Case studies of a relevant workplace to clinical scientists and engineers (eg)
a) Challenger disaster
b) Pinto

Intended Learning Outcomes: The student should have:
- a critical and nuanced understanding of the subtleties and broader contexts of ethical issues in engineering. (M5)
- An ability to evaluate and apply an ethical principles approach to ethical decision making and professionalism (M5)
- A critical awareness of business ethics in a variety of engineering contexts (M5)

The student should have an ability to:
- Understand and critically analyse soft regulation (ie non legal) within relevant areas of engineering practise and apply them to effect leadership decisions. (M2)
- Think critically and independently, locating their career experiences within the context of modern society. (M16)
- present ethically justifiable analyses of governance considerations in engineering. (M5)

Assessment: Presentation (20%)
Assignment 1 (80%)

Assessment Description: 1 x 2000 word essay

Moderation approach to main assessment: Moderation by sampling of the cohort

Assessment Feedback: Written, individual feedback on individual essay

Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.

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

The College of Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework and continuous assessment

This module is only available to students following the COATED/ M2A EngD scheme.

EGSM02 Interpersonal Skills for Engineers

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof JH Sullivan, Prof DJ Penney, Prof G Williams

Format: 25 hours lectures and presentations
75 hours private and directed study and preparation of deliverables
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

Continuous assessment of oral presentations, visual aids and paper abstract and project plan. Full participation in all aspects of the programme are considered neccessary to complete the course.

Module Aims:

The module will cover both presentation and written skills required for successful communication in enigineering.

Presentations: Guidelines on making format presentations, considering attention span, visual aids, style, content and balance to ensure a memorable outcome.
Preparation for one-on-one discussions, approaches to ensure successful meetings.
Body Language: The influence of body language in communication both in formal presentations and in small group discussions. How to read body language in others, and modify your own body position to aid communication.

Written: Guidelines on report preparation, including planning,structure and use of figures and tables. Preparation of an abstract, covering length, key issues and style for maximum effectiveness.

Each candidate will prepare a detailed project plan covering background to the research, the scheduling of practical and other work, and milestone deliverables. This plan will be produced following: (i) attendance at specialist lectures covering issues of good practice in the conduct of research eg safety, procedures for laboratory work and data reporting/analysis; (ii) discussion with academic and industrial supervisors regarding technical/commercial issues associated with the specific topic; (iii) a review of the formal course units covering technical issues, personal and professional development and research skills. The overall report must demonstrate that each student relates relevant aspects of the training courses to their industry oriented research project.

Module Content: Written: Guidelines on report preparation, including planning,structure and use of figures and tables. Preparation of an abstract, covering length, key issues and style for maximum effectiveness.

Oral: Guidelines on making format presentations, considering attention span, visual aids, style, content and balance to ensure a memorable outcome. Preparation for one-on-one discussions, approaches to ensure successful meetings.

Body Language: The influence of body language in communication both in formal presentations and in small group discussions. How to read body language in others, and modify your own body position to aid communication.

Approach: The programme involves formal training with guidance notes supported by a video-tape package on 'Speaking', and direct participation. Discussions of individual performance are undertaken on a group basis with a strong element of interactive participation.

Information retrieval and synthesis
Setting goals and defining deliverables
Managing research progress
Delegation of tasks
Cost and resources implications
Gantt charts
Thesis planning and writing
Inserting and formatting references
As well as project planning, this module includes a short course aiming to:
Identify and define transferable skills
Provide a rationale for skills via both research evidence and stated employer/sector needs.
Provide the opportunity to identify and practise skills needed by engineers, including: communication skills, group-work and team-work skills, negotiation skills and problem-solving skills.
Offer a self-perception inventory to identify and develop future employability skills.

Overview of Personal Development aspect:

1. To raise awareness of:
(a) Individual strengths and weaknesses
(b) Personal impact on others
(c) Interpersonal effectiveness.
2. To further develop personal effectiveness in leading and working with others.
3. To build the participants into a cohesive, achievement-focused team.

Syllabus:
Self Awareness - The Identification of individual strengths and weaknesses.
Interpersonal Effectiveness - Asking for and receiving feedback on the personal impact made on others.
Response-ability - Becoming more response-able. How to change beliefs and behaviours that do not empower the individual and other people.
Positive Influencing Skills - How to assert yourself and negotiate effectively in everyday work situations.
Action-Centred Leadership - How to lead and inspire a team.
Effective Teamwork - How to work effectively with others to achieve mutually agreed goals. Understanding what makes teams effective and how teams develop.
Self-Management - How to identify what matters most to you, and organise your life/work accordingly. The importance of vision, roles, goals and proactive planning.

Approach:
The programme will be a 3-day residential course which will include a number of leadership and team challenges, both in, and outdoors, with an emphasis on learning by experience and reflection. The exercises will be mentally, rather than physically challenging.

Assessment:
Self-assessment and feedback from both colleagues and the programme facilitators will lead to the preparation of an “Action and Development Plan” at the end of the programme. With guidance from the programme facilitators, this will include the actions to be taken to improve personal effectiveness, and the further areas for development that have been identified. The “Action and Development Plan” will be discussed after the course by the participants and their

mentors, to help the participants develop even further.

Intended Learning Outcomes: Competence Statements: After completing this module you should be able to demonstrate self-direction in solving problems, to act independently and professionally in planning tasks and presenting work, to develop your professional presenting skills and to be able to think quickly in unpredictable situations. In addition, you will have gained additional skill in presentation of technical work to a multidisciplinary audience. (M16 and M17)

Students will develop skills to plan a continually monitor a research project and be able to rapidly develop mitigation strategies to ensure projects are delivered enabling their personal responsibility to deliver projects (M16)

After completing this module you should be able to demonstrate:
The ability to plan a research project
A knowledge of and ability to use research information sources
An ability to plan and produce Gantt charts for project planning and time management
An understanding of skills required for team working, negotiation and problem solving
The ability to develop realistic plans with measurable goals to solve challenging, multidisciplinary engineering problems.
The necessary skills to write a scientific report containing appropriately formatted references. (M2 and M4)

Assessment: Presentation (50%)
Assignment 1 (50%)
Group Work - Practical (0%)

Assessment Description: Oral presentations
-prepared presentation on technical topic
-presentation on un-seen topic
Abstract Writing
Project Plan
Personal Development - team building

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Feedback will be provided on written reports and immediately following verbal presentations

Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.

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

Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.

Practical work: Practical presentations to an audience on a variety of topics.

Full course notes are provided.

This module is only available to students following the COATED/M2A EngD / MSc by Research schemes.

EGSM03 Literature Review of Industrial Problem

Credits: 30 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof JH Sullivan

Format: Meetings with supervisors

Delivery Method: Bi-weekly briefings on the progress of the review work. An initial lecture will introduce topics including English for academic purposes, searching for literature, relevant sources, writing journal style papers, referencing and presenting. These will be backed up by one-on-one meetings with a supervisor who will provide guidance and feedback on an ongoing basis. The project itself will be associated with the Research Centres within the College of Engineering

Module Aims: The module involves the collation, refinement and critique of existing literature surrounding particular problem associated with the research topic elected by the student. The student will gain experience in working independently on a substantial, individually assigned task, using accepted literature review procedures. It will require and develop self-organisation and the critical evaluation of existing literature with a view to producing a comprehensive review of the current knowledge on the prescribed topic. Assessment of the literature review will be in the form of a 25 page review paper and a 30 min oral viva examination.

Module Content: - The nature of the research project varies from one student to another. The allotted project will involve survey of literature. The literature review will be on students doctorate topic.
- Each student will be provided with an individual supervisor. It is recommended that students meet their supervisors at least once a fortnight to discuss progress.
- Briefings on literature reviewing, report preparation and presentation skills will be given.
- A final report in the form of a Journal article (25 pages max) will be submitted for review before the end of May and final, "camera ready copy", taking account of reviewer's comments, must be submitted by the end of July
- Each student will attend an individual 30 minute viva voce examination at the end of the project period with 2 members of academic staff. A suitable presentation (10 minutes) should be prepared.

Intended Learning Outcomes: After completing this module you should be able to
- formulate and plan an industrial related research project specifying the aims, objectives and realistic targets; (M5)
- propose and monitor the various activities associated with the project; (M16)
- identify and critically analyse a range of literature and information sources related to your research project (M4)
- Develop a systematic knowledge of your research discipline through collation and discussion of the latest literature related to the Doctorate project (M1)
- formulate and compose a journal article summarising your knowledge of the discipline through critical analysis of current literature. (M1)
- compose an oral presentation (plus PowerPoint) on the findings of the review and defend it against critical appraisal; (M17)

Assessment: Written report - Individual (75%)
Viva (25%)

Assessment Description: 25 page journal style review paper of current literature associated with research project

Moderation approach to main assessment: Moderation by sampling of the cohort

Assessment Feedback: Feedback will come from formative marking of the 25 page literature review and a feedback sheet regarding the viva.

Failure Redemption: The students will be able to re-submit the report before the end of August of year one of their studies for re-evaluation

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

Only available to students completing the Engineering Doctorate Programmes with COATED/ the Materials and Manufacturing Academy. The students will submit a maximum of 25 pages in size 12 font. In addition, attendance at a viva examination at which the review results will be presented and the students knowledge will be assessed is a compulsory part of the assessment. The College of Engineering has a ZERO TOLERANCE penalty policy for late submission of coursework and continuous assessment.

EGSM06 Deposition of functional materials by printing and coating

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr EH Jewell

Format: 20 hour formal lectures
80 hours private directed study
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

Intensive lecture based delivery over three days

Module Aims: Provide overview of coating processes that are applicable for the deposition of functional coatings and to provide an understanding of their capabilities and commercial maturity. This module will provide students with an appreciation and knowledge to address up-scaling of laboratory printing and coating processes to a commercial scale.

Module Content: The course will cover :
1. Introduction : Products and applications which make use of functional coated materials to rigid and flexible substrates. How value is added by coating
2. Classification of printing / coating processes : Patterning and non patterning process,
3. Key coating material science properties : Surface wetting, rheology, solvent evaporation rate, dispersion quality, solids.
4. Coating process : Pre metered processes; slot die, slide die and spray. Self metering processes : blade coating, knife coating, meyer bar, multi roller coating, engraved roll coating and dip coating.
5. Patterning processes : Principle classification in terms of material requirements, film thickness, resolution, substrate compatibility, manufacturing speed and capital costs. Operational principles, applications and process characteristics of screen printing, gravure, flexography, offset lithography and inkjet.
6. Curing : Curing technologies Hot air, UV , IR. Dryer design for efficient cure and common issues in ensuring complete cure.
7. Reel handling : Key aspects of high throughput processing of reels / coils of material and their impact on machine design, productivity and capability.
8. Product finishing techniques : laminating, slitting, embossing, cutting.

Intended Learning Outcomes: After completing the module, students will be able to :
1. Critically analyse the opportunities for the value added products by deposition of functional materials and identify key challenges in their manufacture (M1)
2. Demonstrate a detailed understanding of material requirements for each printing / coating process and the implications of these requirements on functional material formulation. (M1)
3. Demonstrate fundamental knowledge of each liquid coating / printing process and be able to clearly identify the relative merits of each process. (M1)
4. Demonstrate the systematic understanding which allows potential processes to be identified based on application and material requirements (M5)
5. Use acquired knowledge of materials and process to assess health and safety and environmental issues posed by current and newly developed printing processes. (M5)

Assessment: Examination (50%)
Coursework 1 (50%)

Assessment Description: Assessment 1 : 2 hrs multiple choice examination
Assessment 2 : Coursework

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Formative marking provided on continuous assessment with exam feedback available where required.

Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.

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

This module is available only to students following the COATED/M2A EngD/ MSc by Research schemes.

EGSM08 Economic Appraisal of Engineering Projects

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr M Evans

Format: Interactive seminar style lectures and practical laboratory computing.
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

Formal lectures followed by an exercise to be carried out during the teaching week on Excel. This exercise relates to a hypothetical investment in plastic coating equipment for sheet steel manufacture.

Module Aims: Introduction to the financial appraisal of engineering projects including financial accounting, models of investment appraisal, risk and risk management, and capacity optimisation in the face of uncertainty. Coping with such uncertainty requires a basic understanding of techno - economic forecasting techniques.

Module Content: Introduction: Engineering projects defined, the importance of time emphasised and the reasons for investments in steel manufacturing outlined.
Accounting: Production costs, revenue, depreciation, tax laws and cash flows.
Techno - economic forecasting: Forecasting uncertain demand and other key economic variables using growth models, grey systems and intensity of use techniques.
Models of Investment Appraisal: Compounding, discounting, time value of money, payback, net present value, internal rate of return.
Risk and Risk Management: Types of risk, risk management options, risk assessment, sensitivity analysis, probabilistic risk assessment.
Capacity optimisation in the face of uncertainty: Genetic algorithms, RISKOptimiser.

Intended Learning Outcomes: Competence statements: After completing this module you should be able to systematically use the complex techniques to appraise investment projects in the engineering sector. Emphasis is placed on the risks associated with such projects and methods of coping with such risks. You will develop your assessment individually and develop an independent solution to complex investment problems using computer based assignments. (M2 and M3)

Specialist knowledge and understanding: The module will help you to build a thorough understanding of the conceptual basis on which the practice of corporate investment analysis is built, establishing the user need, assessing and forecasting the market and developing an implementation plan. (M1)

Solution of engineering problems: The module will give you the skills to incorporate the latest computer orientated tools for making informed financial decisions within an economic environment of great uncertainty and risk allowing you to make recommendations for investment strategy. (M5)

Technical and commercial leadership: The module will allow you to satisfy the very practical need that Engineers will be called upon to make informed financial decisions when acting as team members/managers of engineering projects. You will also gain an appreciation of the important relationships between customers and suppliers that help in making the correct business decision. (M16)

Assessment: Other (100%)

Assessment Description: Computer based assignment. Students will build an Excel model to assess the likely profitability and degrees of risk resulting from investing in a new coating line to produce organically coated sheet steel. All stated AHEP learning outcomes will be assessed using this assignment.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Students will receive feedback on their coursework, together with detail comments on omissions and errors made, within three weeks of submission

Failure Redemption: Students will be offered the opportunity to resist the coursework in the next year of their degree programme.

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

Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded.

The course requires familiarity with the spreadsheet - EXCEL and the add-in @Risk. Students are advised to learn this package and the add-in before attending. Each Engineer will be provided with lecture handouts.

This module is only available to students following the COATED/M2A EngD/MSc by Research schemes.

EGSM09 Industrial Process Control and Optimisation

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr M Evans

Format: Interactive seminar style lectures and practical laboratory computing.
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

Interactive seminar style lectures and practical laboratory computing.

Module Aims: This module introduces the engineering student to the techniques available for designing and implementing efficient linear and nonlinear industrial experiments. Participants will also be made aware of the limitations present in standard Taguchi experimental designs and how to use the results from such experiments to control and optimize complex manufacturing processes that are either linear or non linear in nature. emphasis is placed on reducing process variation whilst maintaining desired material properties.

These techniques are illustrated using the ausforming and other processes for the production of high strength steels and a case study on friction welding.

Module Content: Quality through experimentation: Overview of designed experiments, robust design, location and dispersion effects, planning programmes of research, case studies.

Linear (two level) factorial designs: The 2(2), 2(3) and 2(k) designs.
Linear (two level) fractional factorial designs - The 2(k-1) and 2(k-p) designs, liaising, confounding and resolution. Probability plots. Replication.
Taguchi Designs - The L(8) and L(16) designs, linear graphs and poor resolution.
Non linear designs: 3(k) designs, central composite designs, Box-Behnken designs and mixed level factorial designs
Optimising linear processes: Location effects, PerMIA statistics, interactions, Yates algorithm, robustness, modelling and placing mean quality on target and minimising process variation. Illustrated using the ausforming and friction welding process.
Optimising non-linear processes: Sequential testing of non linear processes, dual response surface methodologies.

Intended Learning Outcomes: Competence statements: After completing this module you should be able to a demonstrate comprehensive and up to date understanding of the practical applications of statistically designed experiments. The module will help you independently develop your skills in designing and implementing complex experimental programmes to satisfy the practical need of Engineers to find innovative ways to improve their company's processes and products in order to remain world class competitive. (M2)

Specialist knowledge and understanding: The module will provide you with new theoretical approaches to help you statistically design experimentation in an innovative format that will promote the development of new products and processes through experimentation and continuous improvement. (M5)

Solution of engineering problems: You will incorporate the latest software products used to assist in the development of empirical models, via designed experiments, of manufacturing systems. The design of experiments is critically important in the development of viable implementation plans and you will be provided with data in the assignments which will require analysis, assimilation and comprehension to enable project plans to be formulated effectively. (M3)

Technical and commercial leadership: You will gain and enhance skills aimed at maximising experimental efficiency and productivity of research. The tools will also help you evaluate project progress and enable suggestions on continuous improvement. (M5 and M16)

All stated AHEP learning outcomes will be assessed through the completion of a computer based case study.

Assessment: Other (100%)

Assessment Description: Computer based assignment on the quality of welds produced via the friction welding pocess. Students will design a non linear experiment in relation to this process and build a second order response surfacemodel for the mean and variability in weld quality. This model will then be used to optimisation the quality of the weld.
Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit
Assessment Feedback: Students will receive feedback on their coursework, together with detail comments on omissions and errors made, within three weeks of submission.
Failure Redemption: Students will be offered the opportunity to resist the coursework in the next year of their degree programme.
Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus. Failure to sit an examination or submit work by the specified date will result in a mark of 0% being recorded. The course requires familiarity with Excel spreadsheets. This module is only available to students following the COATED/M2A EngD / MSc by Research schemes.

EGSM10 Entrepreneurship for Research Engineers

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof JH Sullivan, Prof I Mabbett

Format:
Day 1 - 7 Hrs
Day 2 - 7 Hrs
Day 3 - 6 Hrs
Open Tutorials - 3 Hrs
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

Interactive workshops run over 3 consecutive days with guest speakers, discussion and practical application throughout the workshops.

Module Aims: To show the concepts and characteristics behind Enterprise and Entrepreneurs and to demonstrate the skills allowing an individual or group to operate successfully in an Entrepreneurial manner in a personal start-up or corporate business environment.

Module Content: Part 1 - What is Entrepreneurship and do you think you have what it takes to be an Entrepreneur?
Module aims, objectives, structure and assignments
Entrepreneurship and Enterprise definitions, benefits and value, Social entrepreneurship, Corporate entrepreneurship and Engineers as Entrepreneurs - discussion
Conduct and review “Enterprise Catalyst” - exercise
Are you an Entrepreneur? - discussion
Examples of Entrepreneurs - discussion
Can you become an entrepreneur – nature/nurture!!! - discussion

Part 2 – Starting Up & Some Inspiration!
Case study – The Big Ideas Role Models
Feedback and thoughts on case studies
Setting up a business in the UK

Part 3 – Creating Ideas and Getting it Across
Idea generation techniques
Networking
Pitching

Part 4 – People you need to make your Ideas work (Personal & Professional Development)
Structure of a business
Management styles
Leadership styles
Teams
Skills sets

Part 5 – Pitching your Ideas - Team Selection
Pitching of Ideas for group assignment and Networking Session to generate teams for group assignment

Part 6 – Planning your Ideas (Business Planning)
The Lean Canvas
The Value Proposition Canvas
Practice

Part 7 - Funding your Ideas
Outline of finance routes

Part 8 – Protecting your ideas and selling your Ideas
Intellectual Property
PR, Marketing & Sales

Intended Learning Outcomes: A detailed understanding of the concepts of Enterprise and Entrepreneurship and a critical analysis of the qualities typically associated with an Entrepreneur. (M1)

Formulate and modify ideas for business/product creation using various individual and group techniques. (M5)

Develop a greater understanding and maximise application of your own personal and professional skills (including leadership, communication, pitching and networking.) (M16 and M17)

Create and develop a team within an Entrepreneurial environment. (M16)

Have a conceptual understanding of the legalities, mechanisms of raising finance and the business knowledge (including sustainability and business plan development) of starting a business. (M5)

Be inspired to utilise all of the above to be Entrepreneurial in any environment.

Assessment: Other (100%)
Assessment Description: Submission of Business Model 'lean canvas' and 500 word reflection.
Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit
Assessment Feedback: Group discussions during module at the end of each day and at open tutorials.
Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.
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 to students following the COATED/M2A EngD scheme.

EGSM12 Applied Instrumental & Analytical Techniques

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr DJ Warren

Format: Lectures over 4 days (16 hours), Coursework Example class (2 hrs), Lab visits (2 hrs), plus 80 hours directed private study.
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

3 days of lectures (6-7 hours per day).

Module Aims: The various research groups based in the department of Materials Engineering hosts a truly World-class suite of materials and coatings characterisation and analysis equipment. The module is designed to give an overview of all the techniques available to students during their postgraduate research.

Module Content: The Module is divided broadly into 8 themes.

Theme 1 – Spectroscopy
Theme 2 – Electrochemistry
Theme 3 – Materials characterisation
Theme 4 – Thermal techniques
Theme 5 – Accelerated weathering
Theme 6 – PV characterisation and other electronic devices
Theme 7 – Manufacturing and printing
Theme 8 - Applied photochemistry

Theme 1 – Spectroscopy, will discuss UV-Vis, FTIR, Raman Spectroscopy, as well as Fluorometry

Theme 2 – Electrochemistry, will give a case study showing the benefit of utilising several electrochemical techniques in order to prove a single hypothesis

Theme 3 – Materials Characterisation, will look at techniques such as, XRD, SEM, BET, XPS, SIMS, AFM, profilometry and contact angle measurements

Theme 4 – Thermal techniques, will look at techniques such as, TGA, DSC, DTA, as well as combined "hyphenated" thermal techniques

Theme 5 – Accelerated weathering, will look at photodegradation of polymer coatings, UV and Atlas weathering, salt spray, as well as techniques such as ICPMS & GCMS

Theme 6 – PV characterisation and other electronic devices, will look at techniques such as, solar simulation IV measurements, IPCE and various time and frequency resolved techniques, and lifetime testing of photovoltaics and other devices.

Theme 7 – Manufacturing and printing, will look at lab scale techniques such as spin coating, bar casting and screen printing. It will look at medium-sized scale-up techniques and will also give an overview of large-scale techniques available at SPECIFIC'S Pilot and Manufacturing Resource Centre (PMRC).

Theme 8 - Applied photochemistry, will discuss the use of time resolved laser spectroscopy and its application to materials chemistry

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

aAfter completing this module students should be able to demonstrate:

a) a fundamental knowledge of a variety of instrumental and analytical techniques that are used to apply and evaluate new functional coatings (M1)

b) the ability to choose the most appropriate analytical technique for a particular aspect of your research project (M2 and M4)

c) an appreciation of the many sub-fields within Materials Science and Engineering and how these share the common theme of linking materials structure and physical properties (M1)

d) an understanding of how these sub-fields are linked, how they have some analytical techniques in common (for example electrochemical techniques in both corrosion and battery research) and how this can promote cross-disciplinary research (M1)

e) the ability to design experiments, suitable for their research projects, to make a prediction on the results expected and the conclusions that may be able to be drawn from said results (M2)

f) Be able to critically evaluate the advantages and disadvantages of analytical techniques to enable them to select suitable methods for their research. (M3)

Assessment: Assignment 1 (100%)

Assessment Description: Essay (3000 words) - 100%

The pass mark for the module is 50%.

Moderation approach to main assessment: Universal Double Blind Marking of the whole cohort

Assessment Feedback: Feedback will be provided via Canvas.

Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.

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

Module to be available to EngD and MSc by Research students enrolled on specific schemes of study within Engineering and as a module for industrial delegates for CPD purposes.

EGSM34 Leadership and Complexity Management (EngD)

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): External Provider / Prof JH Sullivan

Format: 21 hrs workshops
4 hrs tutorials

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

Workshops and tutorials

Module Aims: One of the key skills identified by employers in all sectors and for life in general is the ability to work in a team and to be able to lead! Additionally, there are a number of other skills and traits required or to at least be aware of, to be most effective in these capacities.

This module is designed to utilise contemporary psychology theories to develop individual and group awareness of personal attributes and group characteristics salient to leadership and effective membership of a team.

This is then applied directly using self and group reflection, discussion and debate and exercises to establish team roles and “hammer together” pre-defined teams. This will allow them to move closer to being an “effective team” and ultimately increase success throughout the program.

Effective communication will be promoted throughout the module, in terms of leadership and team work alongside engagement with internal and external stakeholders, to include such areas as sales, marketing and personal branding.

Successful delivery of engineering business outcomes in a developing or high risk environment requires a detailed understanding of the broader complexities involved. This will include risk analysis and preparation, and an understanding of how your project impacts local stakeholders, in particular cultural issues, local politics and vested interests.

This module will explore these complexities and develop strategies to enable successful delivery by seeking to address the potential risk during the programme’s inception as opposed to reacting to unforeseen circumstances during operations.

The module will equip participants with the skills and methodology to deliver programmes in environments that would normally be the preserve of the UN, DFID, specific NGOs or the Military.

Module Content: Leadership styles and what makes a good leader - practical exercises, personal reflection and discussion throughout

Team roles and what makes an effective team - practical exercises, personal, team reflection and discussion throughout

Practical leadership and team development - practical exercises

The importance of effective communication - case studies, practical exercises, personal and team reflection throughout

Strategic risk analysis

Identification of source information

Contingency planning

Working with or in the same environment as the UN, WHO, FCO, DfID and NGOs • Case studies (failure and success)

Development and evaluation of an end to end planning regime

Develop and apply a Duty of Care integrated risk management strategy.

Intended Learning Outcomes: By the end of this module Students should be able to:

1) Critically evaluate personal and team member attributes and strengths in the key areas of leadership, team development, communication, entrepreneurial and innovative thinking and problem solving. (M16)

2) Develop, lead and function as part of a professional and effective team, exercising initiative and personal responsibility. (M16)

3) Analyse and demonstrate effective communication and its critical nature in regard to both leadership and functioning within a team. (M17)

4) Define and evaluate the different roles within an engineering organisation and teams, in regard to personal attributes and technical competence. (M16)

5) Conduct a stakeholder analysis and full risk assessment for the deployment in the project environment, from geopolitical through to technical application. (M5)

6) Evaluate, monitor and maintain full situational awareness in a dynamic environment, making appropriately informed decisions, implementing a Duty of Care Integrated risk management strategy and identifying key human factors increasing risk. (M2)

Assessment: Coursework 1 (100%)

Assessment Description: CW1 - Self diagnostic and team diagnostic report (1000 words) and presentation (10 mins) based on available contemporary theories.

Moderation approach to main assessment: Moderation by sampling of the cohort

Assessment Feedback: Constructive feedback will also be provided during tutorials.

Detailed feedback will be provided with the mark of the final report and presentation.

Failure Redemption: Individual report re-submission following feedback (equivalent to 1000 words). Submission will be at the first assessment point available, following marking and feedback.

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 to Visiting - Exchange students.

EGTM101 Application of Metallic Coatings

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof DJ Penney

Format: 20 hours lectures
80 hours private and directed study
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

3 days of lectures

Module Aims: To provide an overview of metallic coatings composition and application on continuous manufacturing processes.

Module Content: This course will cover the importance of providing corrosion protection to engineering components through coating technologies. It will be taught through illustrated lectures and interactive workshop style seminars and include case studies drawn from the Swansea Corrosion and Coatings research activity. Students will be provided with an opportunity to visit industrial coating lines and gain insight into how process parameters effect the final product and common coating defects. The module will provide comprehensive theoretical understanding of the advancing coatings technology in the strip steel industry which will be of critical value in the design and implementation of the student's research project and in the appreciation of value added products

Specifically the course will cover:-
1. Introduction to the mechanisms (sacrificial, barrier and active inhibition) by which metallic and non-metallic coatings provide corrosion protection.
2. The mechanisms by which various industrially relevant metallic coatings (Zn, Al, Zn-Al and Zn-Al-Mg, tinplate, electro chromium coated steel (ECCS), Ni and Pb) offer corrosion protection and their ability to provide protection for specific applications.
3. Description of the main continuous wide strip coating processes; hot dipping, electroplating, diffusion annealing, physical vapour deposition and the advantages of one technique over another for specific applications.
4. Principles of hot dip coating: pre cleaning, surface activation, hot dip bath composition, control of coating thickness and intermetallic formation, thermal post-treatments including galvannealing.
5. Principles of electroplating: pre-cleaning, electroplating, flow melting, pre-treatment.

Intended Learning Outcomes: 1. Gain comprehensive knowledge of the different ways by which sacrificial and barrier coatings provide corrosion protection. (M1)
2. Identify and critically evaluate the main industrial processes (electroplating, hot dip galvanising, physical vapour deposition) by which metallic coatings are applied to steel and evaluate the advantages of one technique over another for specific applications. (M1)
3. Discuss the mechanisms by which various industrially relevant metallic coatings (Zn, Al, Zn-Al and Zn-Al-Mg, tinplate, electro chromium coated steel (ECCS), Ni and Pb) offer corrosion protection and evaluate their ability to provide protection for specific applications. (M1)
4. Critically assess how economic drivers (high volume, low cost) and environmental and health and safety legislation determine future customer requirements and subsequent product and process development. (M5 and M7)

Assessment: Examination 1 (100%)

Assessment Description: 1 x 4 hour open-book examination

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Feedback on Exam performance will be provided via email notification (to be issued by the Administrative Secretary
of the Course).

Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature. Candidates who pass the training module at the second attempt/re-sit shall obtain an uncapped mark.
Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus. Module to be available to EngD/ MSc by Research students enrolled on specific schemes of study within Engineering and as a module for industrial delegates for CPD purposes.

EGTM102 Substrate technology for functional coatings

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof DJ Penney

Format: 20 hours of lectures
80 hours of private and directed study
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

3 days of lectures including a practical component

Module Aims: This module provides a detailed overview of the important properties and characteristics of substrates that must be evaluated and controlled to enable the subsequent application of organic and in-organic coatings.

Module Content: All coatings are applied to a substrate and REs will develop a fundamental knowledge of how substrate surface metrology and its chemical and physical composition is critical to the subsequent adhesion, manufacture and performance of coatings. REs will investigate typical substrates, such as metals and glass, with regards to their properties and the preparation steps required to enable their coating. This will include the effects of substrate metallurgy and alloying elements, in terms of surface oxidation and wettability, and the effects of preparation technologies, such as cleaning and etching, on surfaces. In addition, REs will learn about the techniques used for substrate characterisation and their limitations. Lectures will be to the cohort of EngDs and take the form of seminar style talks and practical demonstrations. Specifically the course will cover:-

1. Introduction to what is a substrate, what is its role and how substrate properties dictate the type of coating and the coating process.

2. Substrate cleaning methods such as acid / alkali rinse, sputtering, mechanical abrasion and ultrasonic cleaning.

3. Surface analytical techniques – methods and limitations. Includes a practical tests

4. Flatness and wetting – how to measure the flatness of a material and how they relates to coating properties. Explores how wetting issues can reduce adhesion and result in bare / uncoated areas.

5. Mechanical properties of substrate materials as a function of processing and coating.

Intended Learning Outcomes: After completing this module, REs should be able to :-

• Demonstrate advanced knowledge of substrate cleaning techniques and evaluate the link between surface condition and subsequent coating performance (M1)
• Compare and contrast techniques used to measure substrate condition and evaluate their limitations (M1)
• Discuss how heat / mechanical treatment affects the mechanical properties and surface condition of metal substrates (M1)
• Identify and critically evaluate the end of life implications of substrate material selection (M7)

Assessment: Examination 1 (100%)

Assessment Description: 1 x 2 hour examination

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Feedback on Exam performance will be provided via email notification (to be issued by the Administrative Secretary
of the Course).

Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be
redeemed within the maximum period of candidature. Candidates who pass the training module at the second attempt/re-sit shall obtain an uncapped mark.

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

Module available to EngD/ MSc by Research students on specific schemes and to industrial delegates for the purpose of CPD.

EGTM103 Degradation of materials

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof JH Sullivan

Format: 20 hours lectures
80 hours private and directed study
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

Lecture based

Module Aims: To provide a detailed overview of:
The fundamentals of corrosion theory for metals and degradation of organic coatings,
The mechanisms of different corrosion types and their identification in real world situations
The application of corrosion protection techniques through case studies

Module Content: This course will cover both the importance in economic and engineering terms of the degradation of materials, for example, the corrosion of metals and the
electrochemistry of the processes that lead to corrosive failure. Through illustrated lectures and interactive workshop style seminar teaching the group will learn about how corrosion occurs and the general methods for reducing corrosion activity to acceptable levels with practical illustrations drawn from the Swansea Corrosion and Coatings research activity. In addition, delegates will learn about state of the art electrochemical and visual tools and techniques that can be used to image and quantify corrosion reactions and can be used to accelerate product development. Specifically the course will cover :-

1) The theory of the corrosion of metals in terms of thermodynamics and kinetics
2) Degradation mechanisms of organic systems
3) Galvanic corrosion including real world examples and case studies
4) Selective attack corrosion
5) Differential aeration including crevice corrosion and pitting with case studies
6) Corrosion inhibition
7) Anodic and cathodic protection of products and structures

Intended Learning Outcomes: After completing this module students should be able to:-
1. Describe the detailed fundamental electrochemical processes that give rise to corrosion on a variety of metal surfaces and degradation in organic systems. (M1)
2. Evaluate materials suitability and performance and make predictions on likely corrosion failures in example situations. (M1)
3. Critically assess the cost, health and safety and environmental impact of materials degradation issues and mitigation strategies. (M5 and M7)
4. Use fundamental knowledge of corrosion mechanisms to identify and mitigate against design deficiencies that may cause corrosion issues (M2)
5. Select and apply numerical analysis methods to solve electrochemical calculations to evaluate the potential for corrosion to occur (M3)

Assessment: Coursework 1 (50%)
Online Multiple Choice Questions (50%)

Assessment Description: 1 x Coursework - Combination of questions and case studies to answer. 50% of overall mark
1 x Canvas quiz - 21 multiple choice questions. 1 hour to complete once started. 50% of overall mark

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Feedback on Exam performance will be provided via email notification (to be issued by the Administrative Secretary
of the Course).

Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature. Candidates who pass the training module at the second attempt/re-sit shall obtain an uncapped mark.
Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus. Module to be available to EngD/ MSc by Research students enrolled on specific schemes of study within Engineering and as a module for industrial delegates for CPD purposes.

EGTM104 Organic Coatings

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof JH Sullivan, Dr C Lowe

Format: 20 hours lectures
80 hours private and directed study
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.

3 days of lectures

Module Aims: To provide an overview of the formulation and composition of industrial organic coatings and the various industrial processes by which they can be applied to provide corrosion protection to metal substrates.

Module Content: Organic coatings have a broad range of applications from automotive to construction with a plethora of different components and functionality. This course will provide a detailed introduction to the different components and chemistries of organic coatings as well as considering areas of large-scale application. It will be taught through illustrated lectures and interactive workshop style seminars. The module will provide comprehensive theoretical understanding of the advancing coatings technology which will be of critical value in the design and implementation of the student's research project and in the appreciation of value added products

Specifically the course will cover:-
1. The Chemistry of Paint: Fundamentals
2. Analysis of Paints and Coatings
3. The Chemistry of Paint – Polymerisation, Thermoplastics, Oil and Alkyds
4. The Chemistry of Paint – Epoxy resins, Phenolics
5. Polyesters
6. The Chemistry of paint – Pigments and Colour
7. Acrylates
8. Curing
9. Adhesion in Coatings Technology
10. Mechanical Properties
11. Durability of Coatings towards Weather
12. Waterborne Systems
13. Solvents and Additives

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

Develop a comprehensive knowledge of the components of organic coating systems (M1)

Use fundamental knowledge of paint coatings to design an idealised roll-to-roll coating line (M5)

Describe and critically evaluate the benefits and concerns of paint systems for different applications (M1)

Identify and evaluate various methods of assessing the performance of organic coatings (M1)

Assessment: Other (100%)

Assessment Description: 1 x assessment

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Written, individual feedback on individual essay

Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.

Additional Notes: cessary 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 oncampus.
Module to be available to EngD/ MSc by Research students enrolled on specific schemes of study within Engineering and as a module for industrial delegates for CPD purposes.

EGTM38 Elements of Materials Selection

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr DJ Warren, Dr BJ Cockings

Format: 20 hours of Lectures
80 hours of private and directed study
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

Interactive seminar style lectures. 3 days of lectures.

Module Aims: Elements of materials selection. Characterisation of mechanical properties covering elastic behaviour, tensile testing, impact testing and hardness measurement. Atomic and crystal structures of metallic and ceramic materials. Polymer structures and the influence of processing variables. Vacancies and diffusion. Elements of Dislocation Theory: Mechanism of Slip, Slip Systems, Schmidt's Law.
Deformation Processes in crystals: Deformation of Polycrystals, Solid solution strengthening, Fracture of Metals Microstructural evolution covering solidification. Equilibrium diagrams. Equilibrium and non-equilibrium microstructures in plain carbon steels and the effects of heat treatment on mechanical properties. Alloy steels. Dislocation and mechanical properties. Microstructure control of properties in relation to selection criteria for engineering applications.
Phase Transformations in Ferrous alloys
Study of equilibrium and non equilibrium Ferrous transformations, Lever rule

Module Content: Elements of materials selection (1h).
Characterisation of mechanical properties covering elastic behaviour, tensile testing, impact testing and hardness measurement (3h)
Crystal structures of metallic and ceramic materials (3h). Polymer structures and the influence of processing variables (1h). Vacancies and diffusion (1h). Elements of Dislocation Theory: Mechanism of Slip, Slip Systems, Schmidt's Law (3h).
Deformation Processes in crystals: Deformation of Polycrystals, Solid solution strengthening, Fracture of Metals (1h). Microstructural evolution covering solidification (1h). Equilibrium diagrams (2h). Equilibrium and non-equilibrium microstructures in plain carbon steels and the effects of heat treatment on mechanical properties (1h). Alloy steels (1h). Microstructure control of properties in relation to selection criteria for engineering applications (1h).
Phase Transformations in Ferrous alloys (2h)
Study of equilibrium and non equilibrium Ferrous transformations, Lever rule (3h).

Intended Learning Outcomes: Competence statements: After completing this module you should be able to demonstrate:
a) A comprehensive knowledge of materials selection in relation to the structure/mechanical and physical properties/applications of metallic, ceramic, polymeric and composite materials. (M1)
b) have the ability to synthesize and evaluate information from different materials groups to ensure appropriate selection criteria are established. (M4)
c) Solution of engineering problems: The module will underpin your ability to identify project opportunities in harness with your industry sponsor using fundamental knowledge to apply situations to generate next generation materials and technologies for cost effective manufacturing. (M5)
d) Advanced knowledge of the metallurgical principles of ferrous alloys, their development and applications (M1)
e) Establish relationships between processing routes and microstructure to properties, facilitating prediction of engineering properties (M1)
f) Advanced materials selections with steels (M1)
g) Promoting the ability of carrying out self-directed study, including communication skills and computing skills (M16)

Assessment: Attendance (100%)

Assessment Description: No assessment this year (non-credit bearing) - course held to provide a base knowledge for students without a materials engineering background.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Feedback will be provided via the EngD Administrator (via email notification).

Failure Redemption: N/A

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

Full course notes provided via Canvas, based on the PowerPoint presentations, used for the lectures.

Not available to visiting or exchange students.

Materials Engineering graduates could elect to attend this module as an optional module.

This module is only available to students following the COATED/ M2A EngD / MSc by Research schemes.

EGTM98 Electrochemistry

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof G Williams, Prof JH Sullivan

Format: 18 hours formal lectures
2 hours lab demonstrations
80 hours private and direct study
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

Lectures and lab demonstrations over a 3 day period

Module Aims: Electrochemistry basic principles including: Electrode potentials, Nernst equation, dynamic electrochemistry including current-voltage relationships.
Potentiostat based electrochemistry methods including potentiodynamic, potentiostatic, galvanostatic and cyclic voltammetric techniques.
Applications of potentiostat-based electrochemistry methods, especially in corrosion and coatings research.
Advanced electrochemical scanning techniques: basic principles of operation, design and applications.
Scanning reference and vibrating electrode techniques (SRET and SVET) and scanning electrochemical microscopy (SECM) applied to corrosion research.
Introduction to electrochemical techniques for characterising organic coated metals.
Basic principles of electrochemical impedance spectroscopy and applications in evaluating corrosion protection of metals using coatings.
The scanning Kelvin probe technique: principles of operation, design of instrumentation and applications in the study of corrosion protection of metals by organic coatings.

Module Content: • Electrochemistry basic principles including: Electrode potentials, Nernst equation, dynamic electrochemistry including current-voltage relationships.
• Potentiostat based electrochemistry methods including potentiodynamic, potentiostatic, galvanostatic and cyclic voltammetric techniques.
• Applications of potentiostat-based electrochemistry methods, especially in corrosion and coatings research.
• Advanced electrochemical scanning techniques: basic principles of operation, design and applications.
• Scanning reference and vibrating electrode techniques (SRET and SVET) and scanning electrochemical microscopy (SECM) applied to corrosion research.
• Introduction to electrochemical techniques for characterising organic coated metals
• Basic principles of electrochemical impedance spectroscopy and applications in evaluating corrosion protection of metals using coatings
• The scanning Kelvin probe technique: principles of operation, design of instrumentation and applications in the study of corrosion protection of metals by organic coatings.

Intended Learning Outcomes: Develop high level understanding of the theory of electrochemistry and apply the theory to worked examples including calculation (M1)

Obtain knowledge on the impact of electrochemistry on the day to day performance of materials in particular environments and apply this knowledge to materials selection for use in industry (M1)

Develop an understanding for electrochemical testing methods and how they may be used within industry to assist in design and prediction of new materials systems (M1)

Select and apply appropriate numerical methods for solving electrochemical problems (M3)

Analyse how electrochemical influenced corrosion failures could impact on the deliverables of a business and thus spot these problems before they initiate (M5)

Assess the impact of electrochemical materials failures on the working and surrounding environment (M5)

Assessment: Examination 1 (100%)

Assessment Description: 2 hour written examination
Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit
Assessment Feedback: Feedback on exam performance will be provide by a general comments sheet on request
Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.
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 to students following the COATED/M2A EngD/MSc by Research schemes.

EGTM99 Functional Coatings

Credits: 10 Session: 2023/24 Academic Year

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof TM Watson

Format: 20 hours formal lectures and practicals
80 hours private and directed learning
Contact Hours will be delivered through a blend of live activities online and on-campus, and may include, for example, lectures, seminars 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.

(a) Lecturing using a combination of presentation style delivery with handouts, traditional lecture format presentation, group exercises and practical demonstrations

(b) Practical laboratory session on cell assembly and testing

Module Aims: Historically coatings have been relatively benign with developments focussing on increased lifetime or greater control of colour and adhesion. In recent years industry and society have demanded increased functionality for coatings and no more so than in the world of construction. Every year millions up millions of square meters of painted cladded material is produced in the UK. By functionalising just a small percentage of this output to generate, store and release energy it is possible to have a huge impact in the energy and climate challenges set by government. This module will furnish the students with information and knowledge on the various photovoltaic technologies under development, paying particular attention to technologies that utilise earth abundant, environmentally friendly materials.

Module Content: 3 days of study to cover:

Introduction
(a) Course outline
(b) Context (who is involved in functional coatings and what are they?)
(c) Metal coatings (link to course)
(d) Building integrated functional coatings

Types of functional coating
(a) Paint
(b) Self cleaning
(c) Anti microbial
(d) Lighting
(e) Heating
(f) Water cleaning
(g) Transpired solar collectors

Titanium dioxide
(a) What is TiO2
(b) Why is TiO2 so popular in functional coatings?
(c) TiO2 polymorphs
(d) Manufacturing process for titanium dioxide
(e) Band gaps and the link to photovoltaics

Photovoltaics and band gaps
1. (a) Chronology of solar energy development
(b) Photovoltaic and photoelectric effect (Demonstration)
(c) What is a band gap (recap)
(d) Insulators, semi-conductors and conductors
(e) Photo-excitation, valence to conduction band

Introduction to photovoltaic coatings
(a) Silicon solar cells (demonstration), CIGS, CdTe
(b) Comparison of thin film versus rigid PV
(c) PV in building integration
(d) Link TiO2 with Photovoltaics (recap)
(e) Photovoltaics as functional coating (recap)

Dye-sensitized solar cells introduction and recap

Operating mechanism of a DSC
(a) TiO2 deposition and sinter/porosity
(b) Dyeing/sensitization
(c) Redox electrolyte
(d) Platinisation
(e) Encapsulation

Electron pathways
(a) Electron transport in TiO2
(b) Dye injection
(c) Electron regeneration
(d) Recombination

Solid state DSC
(a) Why use a solid state device
(b) Differences between liquid and solid state devices
(c) Hole transport layers
(c) Manufacturing a solid state DSC

Measurement and preparation for laboratory class
(a) Defining performance characteristics (e.g. fill factor, efficiency)
(b) Obtaining an I-V curve
(c) Deriving parameters (group exercise)
(d) Preparation for laboratory practical (walk through manufacturing process)

Practical class - (where COVID restrictions allow)
This 'workshop' will entail the progressive manufacture of a dye-sensitized solar cell on glass. All materials will be provided at the start of the practical and the researcher will be required to carry out all the steps of the manufacture individually.
The day will be run in a show and tell fashion with the lecturer demonstrating each process and the researcher following afterwards. As follows
(a) Deposition of TiO_2 paste
(b) Sinter/heat treatment of TiO_2 layer
(c) Dyeing of the TiO_2
(d) Platinisation of the working electrode
(e) Sealing of the working and counter electrodes
(d) Injection of electrolyte
Following manufacture the researcher will provide the device to a lab assistant who will measure the device using our solar simulator. They will then provide and IV-Curve and a measurement of Fill Factor (this is included as I believe the calculation of FF to be beyond the scope of this course) .
The requirement at the end will be that the researcher label the IV-curve (Isc and Voc), write a short 4 paragraph account of the manufacture and using the IV curve and the equation for photovoltage performance determine a rough efficiency for the device.

Where COVID restrictions are in place the practical will be replaced by a design and integration based activity/assignment to discuss the potential use and application of functional coatings in active buildings for net zero C targets.

Functional Coatings Assessment
Discussion of potential functional coatings in preparation for 'active building' assignment.

Intended Learning Outcomes: Students will gain:

A comprehensive knowledge of functional coatings and their integration into industries to aid economic benefits (M1)

An understanding and evaluation of the various categories of photovoltaic (PV) technologies, Si, CIGS, thin film CdTe, and OPV and their advantages and disadvantages. (M2)

A detailed understanding of the relative efficiency, cost and potential application of PV technologies and an ability to evaluate their impact on the environment and society (M5 and M7)

An advanced knowledge of the theory and manufacturing processes of dye-sensitized solar cells. (M1)

A detailed understanding of the theory and mechanisms behind a dye-sensitized solar cell function, stability, degradation mechanisms and comparisons with other PV technologies. (M1)

Practical demonstrations and cell building workshops within the laboratory will reinforce the key knowledge learning outcomes and develop lab skills. The practical laboratory session will enable the participants to apply their fundamental knowledge in order to design and manufacture a working device from individual components to completion and characterise photovoltaic performance (current output, voltage and efficiency). (M1 and M5)

As a result of this training the participant will have a broad appreciation of the potential application of PV and a detailed understanding of the emerging technologies which are being industrialised in collaborative research programmes led by Swansea with Tata Steel.

Assessment: Assignment 1 (100%)

Assessment Description: 4 page report (including schematics) - present 4 functional coatings that may be designed and integrated into an active building to capture, store or release energy.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Formative marking on coursework.
Failure Redemption: Candidates shall be given one opportunity to redeem a failed training module. All failed training modules must be redeemed within the maximum period of candidature.
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 to students following the COATED/M2A EngD / MSc by Research schemes.