Module Descriptor Form

Civil and Environmental Engineering

CL996 - Materials And Microstructures

Module Code	CL996	**Module Title**	Materials And Microstructures				
Module Registrar	Dobson, Prof Katherine J						
Other Staff Involved							
Credit Weighting	10	**Semester**	2	**Elective**	Yes	**Academic Level**	5
Pre-requisites							
Required for							

Module Format and Delivery (hours):

Lectures	Tutorials	Assignments	Labs	Private Study	Total
8	2	50	10	30	100

Educational Aim

This module aims to:

From concrete to bone, from soil to steel, from pharmaceuticals to stone, the microstructure of a material controls that materials properties, behaviour, performance and how these evolve through time. Innovative materials design, and characterisation of materials structure and evolution under real-world conditions is therefore critical to solving any sustainable engineering challenges. These include developing novel and more sustainable materials and processes, controlling and managing the behaviour of materials under changing real-world conditions to extend useable lifetimes and prevent failure, and end-of-life re-processing. This course aims to provide students with an

- understanding of how microstructures control material performance and properties
- knowledge of microstructural characterisation techniques and how these can be used to assess material properties and develop novel materials
- the ability to develop and apply appropriate testing and analysis protocols to characterise the causes and consequences of material microstructures

The purpose of this course is to give students the skills needed to solve real-life materials-based problems both in developing new more sustainable materials and production processes, and in managing materials performance in operando.

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Syllabus

This module will teach the following:

Topic 1: From micro to macro – the need for microstructural characterisation.
The what, why and the how microstructures control everything about material properties
Topic 2: 2D Characterisation methods
SEM, EPMA and other 2D methods, chemical and physical properties, non-destructive vs. destructive analysis.
Topic 3: Diffraction based techniques
XRD and compositional/structural analysis.
Topic 4: 3D Characterisation methods
X-ray tomography, 2D analysis through time, other 3D techniques.
Topic 5: Image based quantification for materials characterisation
Image analysis and quantification methods for 2D and 3D.
Topic 6: Synchrotron based materials characterisation
How synchrotrons work, applications of synchrotron science for materials characterisation.
Topic 7: In situ analysis – Understanding changes
2D, 3D and 4D Non-destructive in situ testing methods.
Topic 8: Using modelling in materials characterisation
Overview of FEM, DEM, CFD techniques and how they can be applied to microstructural characterisation.
Topic 9: Microstructural Solutions for Sustainability Challenges

Learning Outcomes

On Completion of the module, the student is expected to be able to:

LO: 1	Understand the main microstructural elements that control material behaviours
LO: 2	Understand the principles and methods for 2D, 3D and 4D microstructural characterisation, and how these can be used to develop knowledge of material properties and performance
LO: 3	Apply 2D, 3D and 4D materials characterisation methods and critically assess qualitative and quantitative results to gain understanding of material behaviours and the processes of microstructural change
LO: 4	Can address a key theoretical or applied challenge by integrating and synthesising information; identifying the appropriate characterisation methods and designing a research programme to address the challenge

(UK SPEC suggests no more than 4 learning outcomes per module. Statements must be broad and be syllabus free and link in with the intended learning outcomes on the programme specifications.)

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Assessment of Learning Outcomes - Criteria

Learning Outcome: **1**

	Criteria
1	Can summarize and contrast the key microstructural elements in materials
2	Can identify which microstructures are contributing to specific behaviours or identify ways to determine this

Learning Outcome: **2**

	Criteria
1	Can summarize and contrast the key microstructural characterisation methods
2	Can identify which method(s) are appropriate for a problem
3	Can evaluate and discuss appropriate parameters for microstructural characterisation
4	Can explain how and when physical measurements and computational tools can be used in microstructural characterisation

Learning Outcome: **3**

	Criteria
1	Can apply methods/perform analysis and construct/perform an appropriate data collection and analysis workflow
2	Can interpret qualitative and quantitative microstructural information
3	Can assess uncertainty arising from microstructural analysis and can communicate the implications of that uncertainty on interpretation/understanding
4	Can use data to evaluate material properties, behaviour or processes in engineering & sustainability

Learning Outcome: **4**

	Criteria
1	Can apply advanced problem solving and synthesis skills to identify and define a research challenge/problem
2	Can integrate approaches from different disciplines and evaluate their application to an unrelated challenge
3	Can plan a research/investigation strategy to solve identified challenges in engineering & sustainability

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Assessment Method(s) Including Percentage Breakdown and Duration of Exams

To Pass the module, students need to gain a summative mark of: 50%

Description	Semester	Start Week	Duration	Weight	Submission Week	Linked Criteria
Portfolio Part 2: XRD Report	2	3		20%	5	LO 3: C1, C2, C3, C4
Portfolio Part 4: Peer Review Panel	2			10%	6	LO 2: C3, C4 LO 3: C2 LO 4: C2
Portfolio Part 3: Image Analysis	2	5		12%	7	LO 2: C2, C4 LO 3: C1, C2, C3, C4
Portfolio Part 1: Reflexive Blog	2	0		12%	10	LO 1: C1, C2 LO 2: C1, C2, C3 LO 3: C2
Portfolio Part 5: Project Proposal	2	4		50%	11	LO 1: C2 LO 2: C4 LO 3: C4 LO 4: C1, C2, C3

Principles of Assessment Feedback

Synchronous and asynchronous feedback is provided, and tutor and peer assessment and feedback are both employed. Students are asked to solve problems of different levels of complexity in lecture laboratory and assignments , engage with an assessment exercise (assessing external material) as part of the situated learning component of the course. Guided student background specific self-reflection on the individuals weekly learning is also used to help incorporate learning and enhance feed forwards into future tasks and learning.

Assessment criteria and practices are defined (available on myplace, and discussed with the students) at the beginning of the course, students' comments taken into account, and peer feedback requested on group based activities. The course requires engagement of all students in pre-class, flipped and jigsaw/peer based activities, and the learner agreement and expectations will be discussed extensively at the start of the class. Changes to assessment and feedback required any point during the course will be communicated prior to implementation

Mid-term questionnaires and responses to continual assessment questions will both be used to adjust the teaching approach as needed.

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Additional Information

AHEP Commpetencies:

- Almost all aspects of the Science and mathematics, Engineering analysis, Economic, legal, social, ethical and environmental context and Engineering practice are touched on in the formative assessment throughout the course
- Plan self-learning and improve performance, as the foundation for lifelong learning/CPDKnowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply a range of mathematical and statistical methods, tools and notations
- Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline and the ability to evaluate them critically and to apply them effectively
- Ability to apply quantitative and computational methods, using alternative approaches and understanding their limitations, in order to solve engineering problems and to implement appropriate action
- Ability to apply relevant practical and laboratory skills
- Ability to work with technical uncertainty
- Monitor and adjust a personal programme of work on an on-going basis
- Knowledge of characteristics of particular equipment, processes, or products, with extensive knowledge and understanding of a wide range of engineering materials and components.
- Ability to apply relevant practical and laboratory skills
- Understanding the limitations and benefits of XRD analysis as applied to different groups of materials .
- Understanding of concepts from a range of areas, including some outside engineering, and the ability to evaluate them critically and to apply them effectively in engineering projects .
- Understanding of, and the ability to apply, an integrated or systems approach to solving complex engineering problems
- Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards
- Work with information that may be incomplete or uncertain , quantify the effect of this on the design and , where appropriate, use theory or experimental research to mitigate deficiencies
- Apply advanced problem-solving skills, technical knowledge and understanding to establish rigorous and creative solutions that are fit for purpose for all aspects of the problem including production, operation, maintenance and disposal
- Plan and manage the design process, including cost drivers, and evaluate outcomes
- Communicate their work to technical and non-technical audiences
- Understanding of the use of technical literature and other information sources
- Apply their skills in problem solving, communication, working with others, information retrieval and the effective use of general IT facilities
- Exercise initiative and personal responsibility, which may be as a team member or leader.

Resit Procedure

New submission (different topic) for Portfolio Part 5.

Recommended Reading

There is no pre-requisite reading material.

All recommended core reading material will be made available through the myplace page 2 weeks prior to the start of teaching.

Additional reading materials, for reading prior to teaching activities, and to guide student driven learning will be made available before and along-side the course materials.

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Module Timetable

Week	Semester 1	Semester 2
0		
1		
2		
3		
4		
5		Lab 20%
6		In Person 10%
7		Lab 12%
8		
9		
10		Continuous 12%
11		Submission 50%
E		

Date of Last Modification

06-11-2025