Module specification

When printed this becomes an uncontrolled document. Please access the Module Directory for the most up to date version by clicking on the following link: Module directory

Module Code	ENG7A1
Module Title	Environmental & Sustainable Aspects of Composites
Level	7
Credit value	20
Faculty	FAST
HECoS Code	100145
Cost Code	GAME

Programmes in which module to be offered

Programme title	Is the module core or option for this programme
MSc Composite Materials Engineering MSc Composite Materials Engineering with Advanced Practice	Core

Pre-requisites

None

Breakdown of module hours

Learning and teaching hours	30 hrs
Placement tutor support	0 hrs
Supervised learning e.g., practical classes, workshops	0 hrs
Project supervision (level 6 projects and dissertation modules only)	0 hrs
Total active learning and teaching hours	**30** hrs
Placement / work-based learning	0 hrs
Guided independent study	170 hrs
Module duration (total hours)	200 hrs

For office use only	
Initial approval date	22nd Aug 2022
With effect from date	Sept 2022
Date and details of revision	
Version number	1

Module aims

This module provides insights into the environmental, sustainability and climate change consequences of design for composite materials. Using life cycle analysis, the "Waste Hierarchy: Step Up & Go Green" will be introduced, and options for "Reduce, Re-use and Recycling" will be considered in the context of design for composite engineering components.

Module Learning Outcomes - at the end of this module, students will be able to:

In addition, to the module learning outcomes, student will also cover the following accreditation of higher education programme (AHEP) fourth edition learning outcomes: **M7**

1	Recognise the "Waste Hierarchy – Step Up & Go Green" pyramid, also known as "Lansink's Ladder". Identify each of the six rungs of the ladder with current "Design for Composites" practice.
2	Critically appraise research into recyclability of composites and what value can be ascribed to recyclates
3	Use life cycle analysis to determine the carbon footprint of composites and develop strategies to minimise lifetime greenhouse gas emissions and energy usage.

Assessment

Indicative Assessment Tasks:

This section outlines the type of assessment task the student will be expected to complete as part of the module. More details will be made available in the relevant academic year module handbook.

Assessment One: A time constrained examination covering all learning outcomes. Analytical and descriptive problem-based questions proposed, the student will not have the choice in the questions to be answered to fully assess the whole learning outcomes. Assessment one is a written examination (3 hrs.) and represents 100% of the overall module mark.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)
1	1-3	Examination	100%

Derogations

A derogation from regulations has been approved for this programme which means that whilst the pass mark is 50% overall, each element of assessment (where there is more than one assessment) requires a minimum mark of 40%.

Learning and Teaching Strategies

A series of workshop style lectures with student-led seminars and small group activities. Directed learning using library and internet resources will be facilitated using Moodle and MS Teams. This module will also follow the ALF (Active Learning Framework) guidelines, which

will include alternative methods of assessment and a blended approach to delivery, with some theory and software sessions being delivered online (depending on requirements and student experience).

Indicative Syllabus Outline

- The "Waste Hierarchy – Step Up & Go Green" pyramid, also known as "Lansink's Ladder" will be introduced. Each of the six rungs of the ladder will be linked with an example of a current "Design for Composites" practice. Students will discuss and research this in small groups, and groups will present the outcomes of their activity back to the whole class. Feedback from this exercise will provide early formative assessment for the module.
- For high duty composite components, such as wind turbine blades or safety-critical aircraft components, there are practical limitations on the feasibility of "Reduce, Re-use, Recycling" strategies, and at end of life, the remaining Waste strategies are those in the lower tiers of the Waste Hierarchy: Energy, Incinderation, Landfill. The environmental and sustainability costs of manufacture of such components from pristine raw materials will be discussed, and the consequences for waste management considered.
- There is a growing body of research into recyclability of composites of all types. Some of this addresses the recycling of the polymer, and some with recycling of the fibre. The cost of recycling, and the value or usability of the recyclate will be considered. Additional processing of recyclates has the potential to add value.
- It is recognised that to "Recycle" composite materials, it is necessary to have an effective and systematic method for acquiring the end-of-life parts (without contamination). Logistical processes for this will be considered. Furthermore, a "Design for Composites" strategy in the original component design can play a significant role in cost and waste reduction at the recycling stage by including design methods for disassembly.
- The concept of the Waste strategy "Re-use" has a rather less general application in engineering components than is commonly understood in consumer products. The reasons and rationale for this will be discussed, and the importance of a through-life data record for engineering components will be explained.
- The strategy of "Reduce" in the context of high-performance composite components will be considered. The "Design for Composites" philosophy leads to improvement in engineering geometry and material choices such that materials can be used more effectively. This can lead to a reduction in material usage, or to the development of components with a longer safe life.
- The principles of life cycle analysis applied to the composite landscape. Minimising lifetime energy usage and carbon dioxide emissions. Investigation into other atmospheric, water born and land-based pollutants in the cradle to grave life of composites.

Indicative Bibliography:

Essential Reads

C. A. Mahieux, *Environmental degradation in industrial composites.* Oxford: Elsevier Ltd, 2006.

Other indicative reading

C. Baillie, *Green composites; polymer composites and the environment.* Cambridge and New York: Woodhead Publishing Ltd and CRC Press LLC, 2004.

La Mantia, F. P. (1996) *Recycling of PVC and mixed plastic waste.* Ontario: ChemTec Publishing.

N. P. Cheremisinoff and M. L. Graffia, *Environmental and health safety Management; a guide to compliance.* New Jersey: Noyes Publications, 1995.

Journal. Composite science and technology. London and New York: Elsevier

Plus, various others to be signposted on Moodle.

Employability skills – the Glyndŵr Graduate

Each module and programme is designed to cover core Glyndŵr Graduate Attributes with the aim that each Graduate will leave Glyndŵr having achieved key employability skills as part of their study. The following attributes will be covered within this module either through the content or as part of the assessment. The programme is designed to cover all attributes and each module may cover different areas.

Core Attributes
Engaged
Enterprising
Creative
Ethical

Key Attitudes
Commitment
Curiosity
Resilience
Confidence
Adaptability

Practical Skillsets
Digital Fluency
Organisation
Critical Thinking
Emotional Intelligence
Communication