Module specification

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Module Code	ENG798
Module Title	Composite Manufacture, Assembly & Repair
Level	7
Credit value	20
Faculty	FAST
HECoS Code	101217
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	20 hrs
Placement tutor support	0 hrs
Supervised learning e.g., practical classes, workshops	10 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

- To instil an understanding of the type of composites available and their constituents.
- To develop a knowledge the manufacturing methods commonly used for making composites.
- To understand the issues behind selection of the correct composite for a given application.
- To review the assembly, joining and repair of composites and how this differs from metallic based materials.
- To investigate modern and future manufacturing, assembly and repair of composite components.
- To introduce the procedures used for repair

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

In addition to the module learning outcomes, students will also cover the following accreditation of higher education programme (AHEP) fourth edition learning outcomes: **M2** & **M4**

1	Compare and critically evaluate the various methods of manufacturing a composite, and evaluate the effect assembly geometry on strength and on how manufacturing is undertaken for composites
2	Demonstrate a conceptual understanding of current and future assembly methods to optimise production processing time.
3	Review and recommend preparation methods, adhesive requirements, and repair methodologies for composites

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 written assignment analysing the current manufacture and assembly of polymeric composite components and how the fabrication process influences the repair process. Additionally, new manufacturing and assembly technologies will be reviewed in order to improve and optimise the process. Assessment one is a written assignment (4000 words) and represents 100% of the overall mark.

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

Derogations

Credits shall be awarded by an assessment board for those Level 7 modules in which an overall mark of at least 50% has been achieved with a minimum mark of 40% in each assessment element.

Learning and Teaching Strategies

The module will be delivered through lectures and seminars and combined with interactive laboratory sessions to enhance students' learning. The learning experience will be further supported by tutorials and self-study work and case studies of industrial significance. 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

- Introduction to composite materials and their constituents. Explaining the differences between thermoset and thermoplastic polymers and their key differences. Comparison with metals. Reviewing the types of fibres and matrices available. Basic chemistry leading to an understanding of their properties/ pro and cons of use. Brief discussion of textile structures used in composites.
- Composite manufacturing processes. Hand lay-up, Spray up, Compression moulding, Autoclave moulding, Filament winding, Pultrusion, Resin transfer moulding, out of autoclave methods (like Quickstep processing). Each of these explained and supplemented by pictures, videos etc where appropriate. Discussion on the pros and cons of each technique.
- Introduction to the mechanics of composites and how manufacture influences their properties. Elastic and failure behaviour of ductile and brittle matrix composites. Effect of off axis loading. Effect of fibre length and angle of orientation. An outline of the theory at a superficial level to give a general understanding of the anisotropy of composites and thus how they behave differently to metals. Comparison with metallic structures - anisotropy versus isotropy.
- Assembly, tooling, effect of drilling on composites, fastening (types of fasteners and their effects, torquing of fasteners). Surface preparation of composites for assembly and bonding. Manufacture of stringers, bonding, and co-bonding. Non-contact measurement systems for ensuring alignment. Photogragrametry, laser trackers Managing thickness, control of tolerances during manufacture of components.
- Repair techniques and categories. Outline the strategies and their advantages/disadvantages. Criteria for repair. When is repair required? Bolted / bonded repairs. Bush repairs. Benefits and disadvantages of each. Which is best and what is possible under the rules. Why bonded structural repairs cannot currently be carried out. Cored repairs, how and when to do these?

Indicative Bibliography:

Essential Reads

Broge, J. (2018) *So You Want to Design Aircraft: Manufacturing with Composites.* [Online]. Warrendale: SAE International.

Hull, D. and Clyne, T. W. (1996) *An introduction to composite materials.* 2nd edn. Cambridge: Cambridge University Press.

Other indicative reading

W. Callister, *Materials Science and Engineering.* 7th edn. John Wiley and Sons, 2007.

A. Kelly and C. Zweben, *Comprehensive composite materials (volume 1-4).* New York and London: Elsevier Science Ltd, 2000.

A. R. Bunsell and J. Renard, F*undamentals of fibre reinforced composite materials*

(series in material science and engineering). Bristol and Philadelphia: IOP Publishing, 2005.

N. Tucker and K. Lindsey, *An introduction to automotive composites.* Shawbury: Rapra Technology Ltd, 2002.

T. W. Clyne and P.J. Withers, *An introduction to metal matrix composites.* Cambridge: Cambridge University Press, 1995.

F.L. Matthews, *Joining fibre-reinforced plastics.* London and New York: Elsevier Applied Science Publishers, 1987.

L. Tong and G. P. Steven, *Analysis and design of structural bonded joints.* Boston, Dordrecht and London: Kluwer Academic Press, 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
Communication