

Module Code:	ENG758
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Module Title:	QA, Assembly and Repair of Composites
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Level:	7	Credit Value:	20
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Cost Centre(s):	GSAC	JACS3 code:	H700
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School:	Applied Science, Computing & Engineering	Module Leader:	Martyn Jones
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Scheduled learning and teaching hours	40 hrs
Guided independent study	160 hrs
Placement	0 hrs
Module duration (total hours)	200 hrs

Programme(s) in which to be offered (not including exit awards)	Core	Option
MSc Engineering (Composite Materials)	✓	<input type="checkbox"/>

Pre-requisites
N/A

Office use only

Initial approval: 19/06/2018
 With effect from: 01/09/2018
 Date and details of revision:

Version no:2
 Version no:

Module Aims

- Introduce the basic mechanical characterisation of composite materials and the appropriate testing standards for data reporting.
- Analyse the methods for non-destructive characterisations and their limitations.
- To review the assembly, joining and repair of composites and how this differs from metallic based materials.
- To introduce the procedures used for repair.
- To discuss impact and crash worthiness of composites.
- To review the methods used for quality assurance and inspection of composites.

Intended Learning Outcomes

Key skills for employability

- KS1 Written, oral and media communication skills
 KS2 Leadership, team working and networking skills
 KS3 Opportunity, creativity and problem solving skills
 KS4 Information technology skills and digital literacy
 KS5 Information management skills
 KS6 Research skills
 KS7 Intercultural and sustainability skills
 KS8 Career management skills
 KS9 Learning to learn (managing personal and professional development, self-management)
 KS10 Numeracy

At the end of this module, students will be able to		Key Skills	
1	Critically analyse and implement international testing standards for the characterisation of composites.	KS3	KS4
		KS10	
2	Evaluate and specify non-destructive evaluation techniques of components.	KS3	KS4
		KS10	
3	Make appropriate selections between metallic fasteners whilst being able to analyse the problems of fastener holes and shim requirements.	KS3	KS4
		KS10	
4	Critically review and recommend adhesive requirements for co-bonding, co-cure or adhering dissimilar materials.	KS3	KS4
		KS6	
5	Develop a practical knowledge in how assembly geometry effects component strength and on how manufacturing is undertaken.	KS3	KS7
		KS10	
6	Comprehensively understand automated assembly, fabrication processes and innovative methods	KS3	KS6
		KS10	

Transferable skills and other attributes

1. Communication
2. ICT Technologies
3. Time management and organisation
4. Interpersonal skills
5. Problem solving
6. Information handling including numeracy

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.

Assessment:

Indicative Assessment Tasks:

Assignment 1

A case-study based on the practical industrial issues (e.g. F1 motorsports, Boeing 787 etc.) related to the testing and quality procedures.

Assignment 2

A written examination on the students ability to; analyse assemblies and recommend attachment processes, to investigate component quality and understand how this would affect the component or assembly, understand laminate failure via fracture.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)	Duration (if exam)	Word count (or equivalent if appropriate)
1	1, 2, 3	Case Study	50	N/A	2000
2	4, 5, 6	Examination	50	2 hours	

Learning and Teaching Strategies:

Lectures, exercise classes, laboratories session, directed private study and coursework. Throughout this module, students' learning will also be enhanced by comprehensive problem based learning, i.e. a concept used to enhance multidisciplinary skills using planned problem scenarios.

Syllabus outline:

- Overview of testing and quality control procedures.
- Classical mechanical testing techniques. Use of standard testing methods.
- Specimen preparation
 - Laminate production
 - Quality assurance
 - Strain gauging
- Scaling effects in laminated composites.
- Quality control for composite manufacture.

- Manufacturing defects from testing.
- Introduction to laminate strength analysis.
- Interlaminar shear, tension also delamination and sublaminar buckling.
- Fatigue characteristics unique to composites (e.g. Tension cracking) and comparison with metallics.
- Test Pyramid for composite structures (e.g. durability, coupon, full wing).
- Damage tolerance testing.
- Analysis for allowable damage. Knockdown factors.
- Non destructive evaluation of composite materials and structures
- Environmental testing
- Innovative composite structural health monitoring techniques, i.e. incorporation of nano-structured materials.
- Assembly, tooling, effect of drilling on composites, fastening (types of fasteners and their effects, torquing of fasteners).
- Bonding of composites (Bonding, Cobonding)
- Non contact measurement systems for ensuring alignment.
 - Photogrammetry, laser trackers
- Managing thickness, control of tolerances during manufacture of components.
- Repair techniques and categories.
 - Outline the strategies and their advantages/disadvantages.
 - 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?
- Repair of lightning strike materials.
 - Liquid shim.
- Type of velocity impact on A/C structure.
 - Impact damage – theory and practical. Examples of the types of damage that might be encountered on laminated structures. Effect of layup and potential for use of textile structures.
- Understand Interlaminar toughness mode I and II.
 - What these modes are, how they are measured and what the numbers mean. Use in design of structures.
- Design Priorities for crashworthiness in A/C/structures.
 - Design for composites crash structures. Examples of highly absorbing composite structures, how the problem is approached in F1.
- Use of NDI (Non Destructive Inspection) and methods.
 - Brief review of NDT techniques, their capabilities and limitations. Selection of techniques to determine extent of repair needed and to verify repair has been carried out. Detection of delamination.

Indicative Bibliography:**Essential reading**

Callister, W. and Rethwisch, D.G. (2014), Materials Science and Engineering. 9th ed., Hoboken, NJ: Wiley.

Other indicative reading

Barbero, E.J., (2011) Introduction to composite materials design. Boca Raton, CRC Press.

Vasillev, V. (2013) Advanced Mechanics of Composite Materials and Structural Elements. Oxford: Elsevier Ltd.

Backman, B.F. (2005) Composite structures, design, safety and innovation. Oxford: Elsevier Ltd.

Niu, M.C.Y. (1996) Composite airframe structures; practical design information and data. 2nd ed. California: Adaso Adastra Engineering Centre.

Kelly, A. and Zweben, C. (2000) Comprehensive composite materials (volume 6: design and applications). New York and London: Elsevier Science Ltd.

AE-27 guidebook (1997) Design of durable, repairable, and maintainable aircraft composites. Pennsylvania: Society of Automotive Engineers, Inc. ISBN: 9780768000207

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