MODULE SPECIFICATION PROFORMA

Module Code:	ENG757

Module Title:	Design with Composites

Level:	7	**Credit Value:**	20

Cost Centre(s):	GSAC	JACS3 **code**:	H700

School:	Applied Science, Computing & Engineering	**Module Leader:**	Martyn Jones

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)	✓	☐

Pre-requisites
N/A

Office use only
Initial approval: 19/06/2018 Version no:2
With effect from: 01/09/2018
Date and details of revision: Version no:

Module Aims

- To cover the detailed mechanics of composites and classical laminate theory.
- To apply principles to the choice and design of specific laminate(s).
- To understand the usage of computational methods in aiding the design process.
- To conceptually understand the potential issues that lightning strikes pose to an aircraft and its composite structure.
- Develop critical awareness of the impact of environmental factors on certain type of composites and how that affects their operation.

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	Develop a comprehensive understanding of the mechanical properties of composites based upon classical laminate theory.	KS3	KS4
		KS10	
2	Demonstrate the knowledge and understanding of the applications/limitations of finite elements in lamination design.	KS3	KS4
		KS10	
3	Demonstrate a proficiency in the use of and an ability to produce representative models with composite specific sections of industry standards software such as CATIA V5 and ANSYS.	KS3	KS4
		KS10	
4	Critically evaluate laminate types to enable a group of allowables for initial designs to be created.	KS3	KS4
		KS6	

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:

Assessment 1 – A technical report detailing the Finite Element Analysis and corresponding hand calculations of a composite component. The report will outline the design of a component within specific boundaries set by the assignment

Assessment 2 – A written examination to assess the capability of knowledge in the following areas, the effect of environmental conditions of a polymeric composite, the definition of and calculation of allowable loads in composites and manufacturing of composites and how this affects the mechanical properties of the component.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)	Duration (if exam)	Word count (or equivalent if appropriate)
1	1. 2, 3	Coursework	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:

- Classical laminate theory:
  - Effect of ply orientation, order, symmetry, balance on the characteristics and strength of the laminate. Optimisation, first ply failure. Main failure criteria max strain, max stress, Hills and Tsai?

- FE and specific dedicated computation programmes for composite design:
  - Introduction to FE analysis, how it works? Limitations and pitfalls (is the answer mesh independent? Locking...) Workflow for generating a model. Worked examples and case-studies.
- The diversity of terrestrial environments and their effect on composite components.
  - The effect of water, light, heat can have on polymers and composites. Ageing testing for composite materials and case-studies
  - Effect of hailstones on aircraft structures. Could be the key effect in composite aircraft design! Impact on aircraft structures.

- Manmade potential effects (e.g. solvents, galvanic, acoustic).
  - Reviewing various affects (e.g. swelling for solvents and chemical attack), galvanic cells between metal and composites.
- Fire in composites and transport structures.
  - Effect of fire on materials and the standards to be adhered to in interiors.
- Design of sandwich panels using standard analytical approaches. Examples of where sandwich panels are used in practice (e.g. aircraft flooring).
- Design allowable.
  - Basis and how generated. Testing regime to obtain design allowable. Standards and their application in testing.
- Design applied to standard and innovative types of composite joining processes.
  - Review of joint types (bolted, co-curing, bonded secondary etc). Structural analysis of joints using analytical and FE tools.
  - Hybrid design.
  - Effects of interfacing with metallic components, galvanic corrosion, LSP/EMH, thermal expansion, fatigue.
- Importance of lightning protection for composite material and associated components.
  - Lightning strikes and possible issues. Possible effects of lightning strike and ways of reducing the likelihood of damage. Effect on instrumentation? Earth bonding of aircraft?
  - Standards in lightning design problems (FAA, CAA). Reviewing of standards.

- Understanding the effect of problems and mistakes in manufacturing and how they are resolved. Allowable manufacturing defects in production of composites and their assembly; how this is related to NDT capability.

Indicative Bibliography:

Essential reading

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

Other indicative reading

Gay, D., Hoa, S.V. and Tsai, S.W. (2003) Composite materials, design and applications. London and New York: CRC Press LLC.

Chou, T.W. (2005) Microstructural design of fibre composites, Cambridge: Cambridge University Press.

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.