MSE4118: COMPOSITES

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Composites

Subject Code
MSE - Materials Science and Engineering
Course Number
4118

Academic Unit
Materials Science and Engineering (MSE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
AP2102/MSE2102 Introduction to Materials Engineering
AP2104/MSE2104 Mechanics of Solids
AP3113/MSE3113 Polymer Engineering
MA2157 Foundation Mathematics and Statistics

Equivalent Courses
AP4118 Composite Materials – with An Introduction to Nanocomposites

Exclusive Courses
Nil

Part II Course Details

Abstract

Composite materials are obtained by combining two or more materials together, with one of the materials being in the continuous form. By the correct choice of materials components, and the control of the phases, synergistic effects can be obtained. Carbon fibre reinforced composite materials have found many industrial applications. This course aims to introduce some of the basic techniques for the analysis of composite materials. In addition, an introduction to the potential applications of nanocomposites will also be given.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Apply the basic micromechanics theories in the design of fibre-reinforced composites.			x	
2	Analyze the performance of composites in engineering applications.		x	x	x
3	Describe the potential of nanocomposites in engineering applications.			x	x
4	Identify composite structures that can be found in nature.		x		

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Explain key concepts; explain processing methods, performances, structures and functions of composite & nanocomposites materials.	1, 2, 3, 4	2 hrs
2	Tutorials	Checking students' understanding to lecture contents.	1, 2, 3, 4	1 hrs
3	Laboratory work	Requires students to understand performance and structure of composite materials by carrying out experiment tests.	1, 2, 3	3 hrs/wk for 1 week

4	Group Presentation	Requires 3 to 5 students to form a group and present a topic related to composite materials.	1, 2, 3, 4	3 hrs/wk for 1 week
5	Reading report	Each student is required to write a report on the mechanical performance of composites	1, 2, 3	2 hrs

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments & Lab Report & Group Presentation	1, 2, 3, 4	30	

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained

Assessment Rubrics (AR)

Assessment Task

1. Assignments

Criterion

CAPABILITY for SELF-DIRECTED learning and problem solving

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal level

Assessment Task

2. Group Presentation

Criterion
ABILITY to explain a topic related to composites, including their background, current problems and potential solutions.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal level

Assessment Task
3. Lab Reports

Criterion
ABILITY to explain experimental phenomena and theory related.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal level

Assessment Task
4. Reading Report

Criterion
ABILITY to explain a topic related to mechanical performance of composites

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal level

Part III Other Information

Keyword Syllabus

- Introduction
  Natural and synthetic fibre reinforced composites. Thermosetting and thermoplastic matrices. Fibre properties
- Fibre-matrix interface
  Roles of the interface. Types of interfaces. Characterization of interfaces.
- Micromechanics
  Behaviour of composite laminae. Density and fibre content. Iso-strain and iso-stress models. Halpin-Tsai equation. Longitudinal tensile strength prediction. Transverse tensile strength prediction. Compression behaviour. Hygrothermal behaviour.
- Mechanics of laminae
  Transformation of stress and strain. Constitutive equations for orthotropic lamina.
- Failure criteria
  Maximum stress theory. Maximum strain theory. Tsai-Wu failure criterion.
- Processing of composites
  Hand lay-up. Vacuum bag and autoclaving. Pultrusion. Filament winding.
- Short fibre composites
  Load-transfer length and critical fibre length. Tensile, fracture and toughness properties.
- Metal matrix and ceramic matrix composites.
- Biomimetic
  Nacre. Gecko.
- Polymer nanocomposites
  Carbon tube/graphene nanocomposites. Clay-polymer nanocomposites. Intercalation and exfoliation. Potential applications.

Reading List

Compulsory Readings

	Title
1	D Hull and T W Clyne, “An introduction to Composite Materials 2nd Ed”, Cambridge (1996). TA418.9.C6 H85 1996

Additional Readings

	Title
1	F L Matthews and R D Rawlings, “Composite materials: engineering and science”, Chapman and Hall (1994). TA418.9.C6 M33 1999
2	B D Agarwal and L J Broutman, “Analysis and performance of fibre composites, 2nd ed”, John Wiley and Sons (1990). TA418.9.C6 A34 2006

3	Journal:H.D. Espinosa, J.E. Rim, F. Barthelat and M.J. Buehler, “Merger of structure and material in nacre and bone –Perspectives on de novo biomimetic materials”, Progress in Materials Science 54 (2009) 1059–1100 Y. C. Yuan, T. Yin, M. Z. Rong, M. Q. Zhang, “Self healing in polymers and polymer composites.R. P. Wool, “Self-healing materials: a review”, Soft Matter 4, 400 (2008).S. K. Ghosh, Self-healing materials: Fundamentals, Design Strategies and Applications (BOOK Chapter)S. C. Tjong, “Structural and mechanical properties of polymer nanocomposites”, Materials Science and Engineering R: Reports, 53 (2006) 73-197.