

MSE4118: COMPOSITES

Effective Term

Semester B 2025/26

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

MSE2102 Introduction to Materials Science and Engineering

MSE2104 Mechanical Behaviour of Materials

MSE3113 Soft Materials

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.

Learning and Teaching Activities (LTAs)

LTAs	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 hr
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 ("- for nil entry)	Allow Use of GenAI?	
1	Assignments & Lab Report & Group Presentation	1, 2, 3, 4	30	-	No

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

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
- Metal matrix and ceramic matrix composites
 - Basic concepts, properties, and applications
- 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.